



969900

July 15, 2021

Mr. Craig Thomas
On-Scene Coordinator
U.S. Environmental Protection Agency, Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604

Subject: Air Monitoring and Sampling Plan, Revision 0
Rockton Chemtool Fire ER
EPA Contract No. 68-HE-0519-D0005
Task Order-Task Order Line Item No.: 0032-0001CF104
Document Tracking No. 0733

Dear Mr. Thomas:

The Tetra Tech, Inc. Superfund Technical Assessment and Response Team (START) is submitting the enclosed Air Monitoring and Sampling Plan for the area surrounding the release at the Rockton Chemtool Fire ER site (the site) for your review and approval. This plan summarizes the air monitoring and sampling activities planned for June 2021 at the site in Rockton, Winnebago County, Illinois.

If you have any questions regarding this plan, please contact me at (312) 201-7759 or via e-mail at Cordell.Renner@tetrattech.com.

Sincerely,

A handwritten signature in black ink, appearing to read 'Cordell Renner', written in a cursive style.

Cordell Renner
Project Manager

Enclosure

cc: TOLIN file
Chris Burns, Tetra Tech

**AIR MONITORING AND SAMPLING PLAN
ROCKTON CHEMTOOL FIRE ER SITE
ROCKTON, WINNEBAGO COUNTY, ILLINOIS**

REVISION 0

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Superfund and Emergency Management Division
Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604

Submitted by

Tetra Tech, Inc.
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EPA Contract No. 68-HE-0519-D0005

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Prepared by

Lucas Stamps
Geologist

Approved by

John M. Weber
START QC Reviewer

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1.0 INTRODUCTION

Under Contract Number 68-HE-0519-D0005, Task Order-Task Order Line Item Number (TO-TOLIN) 0032-0001CF104, U.S. Environmental Protection Agency (EPA) Region 5 tasked the Tetra Tech, Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START) to assist with air monitoring and sampling at the Rockton Chemtool Fire ER site located in Rockton, Winnebago County, Illinois (Appendix A, Figure 1). The overall goal of the air monitoring effort is to assess levels of particulate matter, organic vapor contamination, and other chemical concentrations in the air in the areas surrounding the release (Appendix A, Figure 2) and to determine whether these levels pose a threat to human health and the environment.

This air monitoring and sampling plan (AMSP) describes the sampling, analytical, and quality assurance and quality control (QA/QC) requirements for activities at the site. Figures for this AMSP are provided in Appendix A. Tetra Tech standard operating procedures (SOP) to be used during this investigation are provided in Appendix B.

2.0 SCOPE OF WORK

In accordance with the TO-TOLIN, the EPA On-Scene Coordinator (OSC) tasked START with the following objectives:

- Conduct real-time perimeter air monitoring of the site at designated air monitoring stations.
- Collect outdoor (ambient) air samples as determined in the field by EPA.
- Document sampling activities and sampling locations via photographs, digital data capture forms, and written field notes.
- Prepare data validation reports after receipt of final data packages from the laboratory and prepare resident notification letters.
- Perform data management using SCRIBE software and geographic information systems (GIS) mapping to track field team progress.
- Document and summarize the findings in a letter report.

3.0 PROJECT TEAM

The personnel listed in the table below will be involved in planning or technical activities for this site. The OSC and each member of the field team will receive a copy of this AMSP, and a copy will be retained in the site file. Key project personnel are listed in Table 1 below.

TABLE 1: KEY PROJECT PERSONNEL

Personnel	Title	Organization	Phone	Email
Craig Thomas	OSC	EPA	312.886.5907	Thomas.Craig@epa.gov
Cordell Renner	Project Manager	START	314.550.4208	Cordell.Renner@tetrattech.com
Kris Schnoes	QA Manager	START	312.201.7480	Kris.Schnoes@tetrattech.com
Brendan Martin	Field Staff	START	913.548.2487	Brendan.Martin@tetrattech.com
Rachel Houle	Field Staff	START	312.201.7721	Rachel.Houle@tetrattech.com
Kirsten Myles	Field Staff	START	312.201.7407	Kirsten.Myles@tetrattech.com
Sean Spears	Field Staff	START	920.660.8383	Sean.Spears@tetrattech.com
Lucas Stamps	Field Staff	START	317.419.5586	Lucas.Stamps@tetrattech.com

Notes:

EPA U.S. Environmental Protection Agency
OSC On-Scene Coordinator
QA Quality assurance
START Superfund Technical Assessment and Response Team

4.0 SITE LOCATION AND DESCRIPTION

The Rockton Chemtool Fire site is located at 1165 Prairie Hill Road in the Village of Rockton, Winnebago County, Illinois (Appendix A, Figures 1 and 2). The geographic coordinates at the center of the site are 42.4691129° north latitude and -89.066968° west longitude with an elevation of 753 feet. The site consists of an industrial manufacturing facility known as the Rockton Production Center in a mixed commercial and residential area. The site is bordered to the north and west by the Rock River. The areas to the south and east are primarily residential and commercial properties. The site is approximately 700 feet south of the Rock River.

The Rockton Production Center is owned and operated by Chemtool Incorporated (Inc.). Operations at the site include manufacturing of greases, additives, and other fluids including: industrial cleaners, corrosion inhibitors, and metalworking fluids. The Chemtool facility is a Tier II facility under *Title 40 Code of Federal Regulations* (40 CFR) § 312(a) of the Emergency Planning and Community Right-to-Know Act (EPCRA). According to the Tier II report filed by Chemtool in 2020, the facility stores the following chemicals on-site: diphenylmethane diisocyanate, ethylene glycol, nitrogen, lead, sulfuric acid, and zinc. There are no past violations noted on EPA's Enforcement and Compliance History Online (ECHO) Database (ECHO 2021).

On June 14, 2021 at approximately 7:00 am, several fire departments from Illinois and Wisconsin were called to a 4-alarm fire at the site. A one-mile mandatory evacuation area surrounding the site was implemented by the responding fire departments. EPA, Illinois Environmental Protection Agency (IEPA), and START responded on scene to oversee response activities and conduct air monitoring and sampling.

5.0 PROPOSED SCHEDULE

Sampling activities are planned for June 2021. Up to 15 air samples will be collected and analyzed for of metals, PAHs, and VOCs. Sample locations will be based on coverage of the residential neighborhoods to the south, north, and east of the site. Preliminary metals, PAH, and VOC results for air samples submitted for laboratory analysis will be requested as quickly as the laboratory can provide them, likely a 48-hour turnaround time.

Laboratory analytical data will be validated by a START chemist after full Level IV data packages become available (Stage 3 validation). The validated analytical results and other findings will be provided to EPA in a Data Validation Report. Validated analytical results and a summary of real-time air monitoring will be summarized in a Letter Report. The anticipated schedule is outlined in Table 2 below.

TABLE 2: PROPOSED SCHEDULE

Activities	Anticipated Date of Initiation	Anticipated Date of Completion	Deliverables	Deliverable Due Date
AMSP preparation	June 14, 2021	June 16, 2021	AMSP	June 16, 2021
Sample collection	June 2021	June 2021	Logbooks, GIS data	Not applicable
Laboratory analysis	June 2021	June 2021	Preliminary lab report	10 business days after sample delivery
Data validation	Immediately on receipt of the Level IV data package	10 business days after receipt of the Level IV data package	Data Validation Report	10 business days after receipt of the Level IV data package
Letter Report	Two weeks after receipt of Data Validation Report	2 weeks after receipt of client comments	Letter Report	TBD

Notes:

AMSP Air Monitoring and Sampling Plan
 GIS Geographic information system
 TBD To be determined

6.0 FIELD ACTIVITIES AND PROCEDURES

This section outlines and provides rationale for the proposed field investigation activities, as well as procedures for sampling and data collection. As described in Section 2.0, the primary goal of the air

monitoring and sampling activities is to evaluate the potential threat to human health caused by exposure to elevated concentrations of metals, PAHs, VOCs, and particulate matter in air.

6.1 METEOROLOGICAL MONITORING

Meteorological data for each operational area will be obtained continuously from the closest National Weather Service station. The data obtained will include:

- Temperature (°F)
- Relative humidity
- Wind direction
- Wind speed
- Current weather conditions (such as partly cloudy or raining)

6.2 AIR MONITORING

START will have stationary monitoring points at up to 15 locations designated by EPA as well as a roaming team who will be collecting monitoring information at eight fixed discrete locations that are subject to change based on fire conditions (Appendix A, Figure 3). START will also collect roaming monitoring readings at non-fixed locations throughout the area of interest, based on weather and fire conditions.

6.2.1 Stationary Air Monitoring Locations

START will deploy a TSI DustTrak DRX particulate monitor (DustTrak) at select air monitoring stations determined by EPA as well as a Honeywell AreaRAE Pro (AreaRAE) at each air monitoring station. The DustTraks will be used to assess suspended particulates. The AreaRAEs will be used to assess airborne concentrations of VOCs, oxygen (O₂), carbon monoxide (CO), hydrogen sulfide (H₂S), Hydrogen Cyanide (HCN), and the lower explosion limit (LEL). Not all constituents will be monitored on every AreaRAE. Both instruments provide real-time readings for site related contaminants.

The DustTraks and AreaRAEs will be deployed at air monitoring locations determined by EPA, START, and other on-site parties in consultation with EPA. These locations are subject to change as additional needs arise. START will place the DustTraks and AreaRAEs at approximately 4.5 feet above the ground in the typical breathing zone of personnel at each of the air monitoring stations. START will conduct air monitoring in accordance with Tetra Tech SOP No. 073-2, “Air Quality Monitoring” (Appendix B).

The DustTraks are capable of monitoring for particulate concentrations down to 0.1 microgram per cubic meter (µg/m³). The DustTraks will monitor for particulate matter with an aerodynamic diameter less than 1 micron (PM₁), with an aerodynamic diameter less than 2.5 microns (PM_{2.5}), with an aerodynamic diameter less than 4 microns (PM₄, also known as respirable particulate matter), with an aerodynamic

diameter less than 10 microns (PM10, also known as thoracic particulate matter), and total particulate matter. Particulate monitors are factory calibrated and therefore do not require field calibration. However, particulate monitors do require “zeroing” using a filter, which will occur daily before use.

Each AreaRAE contains a photoionization detector (PID) capable of monitoring for total VOCs down to 0.1 parts per million (ppm). The AreaRAE unit also contains sensors to measure percent O₂, H₂S in ppm, percent LEL, and CO in ppm. The AreaRAEs will be calibrated according to the manufacturer's instructions to ensure precision and accuracy of the instrument response to standard.

START will periodically check the equipment to ensure it is operating properly and acquiring data. Real-time readings will be recorded on the device for download onto a computer twice a day, as well as through telemetry.

START will utilize telemetry in order to obtain real-time data and develop a web-viewer for off-site data review and visualization. Software used for telemetry will include EPA’s VIPER system and Honeywell RAE Systems’ ProRAE Guardian system, in which strategically placed relays will communicate real-time results to a remote host computer throughout response activities. Data irregularities and problems will be identified and investigated. Proposed air monitoring locations are shown on Figure 3 in Appendix A (these locations are subject to change as new data comes in and with new EPA direction).

6.2.2 Roaming Air Monitoring Locations

START will utilize a team to conduct air monitoring on a designated route. This route will include up to eight points designated by EPA to cover the evacuation zone. These locations are subject to change based on fire conditions, wind direction, and other plume modelling criteria. Additional roaming monitoring may be performed throughout the site area of interest based on site conditions and direction from EPA. START will utilize a Honeywell MultiRAE Pro (MultiRAE), a handheld TSI DustTrak DRX particulate monitor (HDRX), and two Honeywell SPM Flexes (SPM Flex) at roaming air monitoring locations. An iPad will be used to collect air monitoring data on a Survey 123 form for each roaming point for near real time updates on air quality. All readings will be collected at approximately 4.5 feet above the ground in the typical breathing zone of personnel. START will conduct air monitoring in accordance with Tetra Tech SOP No. 073-2, “Air Quality Monitoring” (Appendix B).

The MultiRAE unit will be used to assess airborne concentrations of VOCs, O₂, CO, H₂S, HCN and the LEL. Each MultiRAE unit contains a PID capable of monitoring for total VOCs down to 10 parts per billion (ppb). The MultiRAE unit also contains sensors to measure percent O₂, H₂S in ppm, percent LEL, HCN in

ppm, and CO in ppm. The MultiRAEs will be calibrated according to the manufacturer's instructions to ensure precision and accuracy of the instrument response to standard.

The HDRX monitor is capable of monitoring for particulate concentrations down to $0.1 \mu\text{g}/\text{m}^3$. The HDRX will monitor for PM1, PM2.5, PM4, PM10, and total particulate matter. Particulate monitors are factory calibrated and therefore do not require field calibration. However, particulate monitors do require “zeroing” using a filter, which will occur daily before use.

The SPM Flexes are capable of monitoring for several different compounds depending on the Chemcassette being utilized. START will utilize a mineral acid tape monitoring for sulfuric acid and a sulfur dioxide (SO₂) tape for SO₂.

START will periodically check the equipment to ensure it is operating properly and acquiring data. Real-time readings will be recorded on the device for download onto a computer twice a day.

6.2.3 Action Levels

Table 3 lists action levels for contaminants monitored on site. Site specific action levels were determined using relevant state and federal benchmarks and will be used to determine if protective actions needed to be taken for residents or workers. Action levels for the level of personal protective equipment (PPE) to be used are based on the approved Site-Specific Health and Safety Plan.

TABLE 3: ACTION LEVELS
PROPOSED ACTION LEVELS BASED ON DIRECT-READING INSTRUMENTS

Parameter	Site-Specific Action Levels ¹	ACGIH TLV	NIOSH REL	OSHA PEL	NAAQS	Level D Action Level ²	Level C Action Level ²	Level B Action Level ²
VOC*	1 ppm	NA	NA	NA	NA	<5 ppm	Any response above background to 5 ppm (sustained for 5 minutes)*	> 5 to 500 ppm*
LEL	NA	10%			NA	< 5%	≥ 5 to 10%	> 10% (evacuate)
O ₂	NA	< 19.5% and > 23.5%			NA	19.5 to 23.5%		< 19.5% or > 23.5%
CO	NA	25 ppm	35 ppm	50 ppm	9 ppm	< 25 ppm	None, use Level B	> 25 ppm
H ₂ S	0.1 ppm	1 ppm	10 ppm	20 ppm	NA	< 1 ppm	NA	> 15 ppm
NH ₃	30 ppm		25 ppm	50 ppm		< 25 ppm	> 25 ppm	>50 ppm
Particulates	PM ₁₀ : 50 ug/m ³ PM _{2.5} : 25 ug/m ³	NA	NA	TWA 15 mg/m ³ (total) 5 mg/m ³ (respirable)	150 µg/m ³	< 2.5 mg/m ³	> 2.5 mg/m ³	NA
SO ₂	0.2 ppm	2 ppm		5 ppm	75 ppb (1-hour) 0.5 ppm (3-hour)	< 5 ppm	> 5 ppm	NA
Cyanates	0.05 mg/m ³	5 ppb (as TDI, MDI, HDI, and IPDI)	5 ppb (as MDI, HDI, and IPDI)	5 ppb (as TDI, MDI, HDI, and IPDI)	NA	< 5 ppb	None, use Level B	> 5 ppb

¹Action levels based on Agency for Toxic Substances and Disease Registry (ATSDR) and Illinois Department of Public Health (IDPH) site-specific recommendations

²PPE determination action levels based on approved Site-Specific Health and Safety Plan

Notes:

> greater than
 < less than
 % percent
 µg/m³ microgram per cubic meter
 mg/m³ milligrams per cubic meter
 ACGIH American Conference of Governmental Industrial Hygienists
 CO carbon monoxide
 COI chemical of interest
 HDI hexamethylene diisocyanate
 H₂S hydrogen sulfide
 IDLH immediate danger to life and health
 LEL lower explosive limit

IPDI	isophorone diisocyanate
MDI	methylene diphenyl diisocyanate
NAAQS	National Ambient Air Quality Standard
NIOSH	National Institute of Occupational Health and Safety
NA	not applicable
NH ₃	ammonia
O ₂	oxygen
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
PM ₁₀	particulate matter with an aerodynamic diameter less than 10 microns
PM _{2.5}	particulate matter with an aerodynamic diameter less than 2.5 microns
ppb	parts per billion
ppm	parts per million
REL	recommended exposure limit
SO ₂	sulfur dioxide
TDI	toluene diisocyanate
TLV	threshold limit value
TWA	time-weighted average

6.3 AIR SAMPLING

START will collect ambient air samples for metals, PAHs and VOCs in accordance with EPA Environmental Response Team (ERT) SOP No. 2008, Revision 0.0 “General Air Sampling Guidelines” (Appendix B). START will collect samples from locations based on EPA guidance. These locations are subject to change as based on site conditions or additional guidance from EPA. The exact location for the ambient air samples will be determined in the field and based on weather conditions and a visual inspection of the area.

Samples that will be submitted for metals will be collected using Gillian GilAir5 low-flow sampling pumps with a 0.8 micron (μm) mixed cellulose ester (MCE) 37-millimeter (mm) filter cassette. Sampling pumps will be set to a flow rate of 2 to 2.5 liters per minute (L/min) and will run for eight hours in compliance with specifications established by the National Institute for Occupational Health and Safety (NIOSH) Method 7300, “Elements by ICP” (NIOSH 2003). Calibration and flow verification will occur prior to deployment and after sample collection is complete in accordance with Tetra Tech SOP No. 064-1, “Calibration of Air Sampling Pump” (Appendix B). Pumps will be placed at approximately 4.5 feet above the ground to represent the typical breathing zone. In addition to the four field samples, a field blank will be collected to be analyzed at a laboratory for metals.

Samples that will be submitted for PAHs will be using Gillian GilAir5 low-flow sampling pumps with a 2- μm polytetrafluoroethylene (PTFE) laminated membrane 37-mm filter cassette. Sampling pumps will be set to a flow rate of 2 L/min and will run for eight hours in compliance with NIOSH Method 5515, “Polynuclear Aromatic Hydrocarbons” (NIOSH 1994). Calibration and flow verification will occur prior to deployment and after sample collection is complete in accordance with Tetra Tech SOP No. 064-1, “Calibration of Air Sampling Pump” (Appendix B). Pumps will be placed at approximately 4.5 feet above the ground to represent the typical breathing zone. In addition to the four field samples, a field blank will be collected to be analyzed at a laboratory for PAHs.

Samples that will be submitted for VOCs will be collected using individually-certified stainless steel 6-liter Summa canisters, attached to 24-hour flow controllers, in accordance with EPA SERAS SOP No. 1704 Revision 01, “SUMMA Canister Sampling” (Appendix B). Summa canisters will be placed at approximately 4.5 feet above the ground to represent the typical breathing zone. Once the Summa canister is in the appropriate sampling location, the canister valve will be opened, and the initial vacuum and start time will be recorded on a sampling data form. After approximately 24 hours, the canister valve will be closed and the end time and ending vacuum will be recorded. Before the Summa canister is closed at the end of the 24-hour sampling period, the Summa canister will be checked with a vacuum gauge to make certain that a vacuum still exists inside the canister.

Samples will be submitted to ALS Global in Simi Valley, California for analysis for VOCs via EPA Method TO-15 (EPA 1999). Sample results will be compared to EPA Regional Screening Levels (RSLs) for Residential Ambient Air with a Target Cancer Risk of 1E-06 and a Hazard Quotient of 1 (EPA 2021).

TABLE 4: SAMPLE SUMMARY

Matrix	Analytical Parameter	Analytical Method	Number of Samples	Number of Field Duplicates	Number of MS/MSDs	Number of Blanks	Total Number of Samples to Laboratory
Air	PAHs	NIOSH 5515	4 per event	1 per event	NA	1 per day	TBD
Air	TAL Metals + Boron	NIOSH 7300	4 per event	1 per event	NA	1 per day	TBD
Air	VOCs	TO-15	4 per event	1 per event	NA	NA	TBD

Notes:

MS/MSD Matrix spike/matrix spike duplicate
 NA Not applicable
 NIOSH National Institute of Occupational Safety and Health
 PAHs Polynuclear aromatic hydrocarbons
 TAL Target Analyte List
 TBD To be determined
 VOCs Volatile organic compounds

6.4 FIELD DATA COLLECTION IN SUPPORT OF SAMPLING

During the sampling event described in this AMSP, START will document the site conditions using written and photographic methods. This documentation will consist of written descriptions of all response activities, including field conditions, observations, site activities, monitoring results, and sample descriptions in accordance with Tetra Tech SOP No. 024-3, “Recording Notes in Field Logbooks” (Appendix B).

7.0 DECONTAMINATION PROCEDURES

Disposable sampling equipment and personal protective equipment (PPE) will be double-bagged and disposed of with all other used PPE waste produced at the site. Reused sampling equipment will be decontaminated between uses in accordance with Tetra Tech SOP No. 002-4, “General Equipment Decontamination” (Appendix B).

8.0 SAMPLE HANDLING

Each sample will be labeled to identify the air monitoring station. The samples will be labeled with the site ID (Rockton Chemtool Fire ER [RCF]), air monitoring station description, and sampling date (YYMMDD). Samples will be identified by a unique sample identification number, as described in Table 5 below.

TABLE 5: SAMPLE NOMENCLATURE

Site	Air Monitoring Station	Date	Example Identification
RCF	Air Monitoring Station at Facility	June 15, 2021 – 210615	RCF-Facility-210615

Sampling locations will be noted in the site logbook and using Esri Field Maps or a similar application in accordance with Tetra Tech SOP No. 024-3, “Recording Notes in Field Logbooks” (Appendix B). The samples collected will be labeled, packaged, and shipped in accordance with procedures outlined in Worksheets #26 and 27 of the START Quality Assurance Project Plan (QAPP) (Tetra Tech 2020) and Tetra Tech SOP No.019-8, “Packaging and Shipping Samples” (Appendix B).

9.0 DISPOSAL OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) will consist of disposable nitrile gloves, paper towels, resealable plastic bags, and plastic trash bags. IDW will be double bagged and disposed of as dry industrial waste in accordance with the EPA Office of Emergency and Remedial Response (OERR), Management of Investigation-Derived Waste during Site Inspections (EPA 1991).

10.0 QUALITY ASSURANCE/QUALITY CONTROL

This section describes the QA/QC procedures for the assessment activities at the Rockton Chemtool Fire ER site. Specifically, this section addresses responsibilities, sample QC procedures, field QC procedures, and data evaluation and management.

10.1 RESPONSIBILITIES

QA/QC requirements will be adapted to project-specific conditions. The START project manager, Mr. Cordell Renner, will be responsible for ensuring that sample quality and integrity are maintained, and that sample labeling and documentation procedures are conducted in accordance with the START QAPP and this AMSP. When laboratory results are received, START will review the laboratory data packages for completeness and will conduct Stage 3 data validation in accordance with the START QAPP (Tetra Tech 2020).

All QA/QC activities will be conducted in accordance with this AMSP. A copy of this SAP will be maintained by the field sampling team for immediate reference in resolving any QA/QC issues that might arise during field activities.

10.2 SAMPLE QUALITY CONTROL

QC samples will be collected to evaluate the field sampling and decontamination methods, and the overall reproducibility of the laboratory analytical results. Specifically, QC samples will be collected at the following frequencies:

- Field duplicate: 1 per event
- Field blank: 1 per event

START chemists will validate the laboratory results in accordance with the START QAPP (Tetra Tech 2020). Corrective actions may include resampling, reassessment of the laboratory's methods, or assignment of data qualifiers to the laboratory results. The findings of the validation will be summarized in a data validation report, as stated in Section 5.0.

10.3 FIELD QUALITY CONTROL

Field QC measures will consist of adherence to proper sampling procedures in accordance with EPA ERT SOP No. 2008, Revision 0.0, "General Air Sampling Guidelines" (EPA 2020). Samples will be shipped in accordance with Tetra Tech SOP No. 019-8, "Packaging and Shipping Samples" (Appendix B), and sampling activities will be documented in the site logbook and Field Maps or similar application as described in the START QAPP (Tetra Tech 2020) and Tetra Tech SOP No. 024-3, "Recording Notes in Field Logbooks" (Appendix B). All direct-reading instruments will be calibrated daily before use and according to manufacturer instructions.

10.4 DATA EVALUATION AND MANAGEMENT

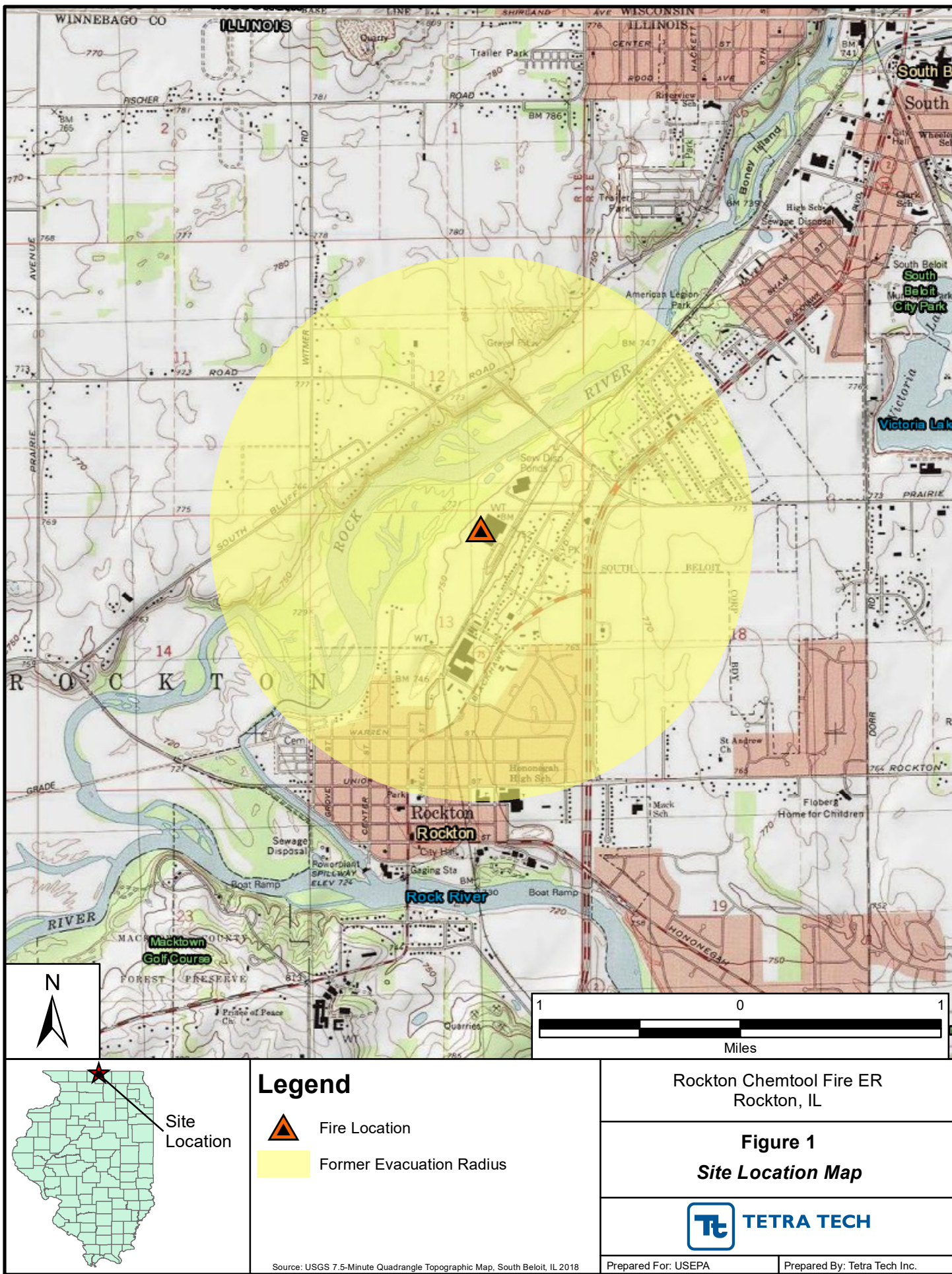
Digital data collected during site activities will be subject to routine QA/QC checks. These QA/QC checks will be performed daily, at a minimum, and will be implemented any time data are transitioned from one operating platform to another. For example, data entered on a tablet computer will be subject to a QA/QC check when they are downloaded from Survey123 or a similar application. The same data will then be subject to a QA/QC check when they are uploaded to the central project SCRIBE database, and a final QA/QC check will be performed as the central project SCRIBE database is populated with analytical results. The SCRIBE database will be published to Scribe.NET to ensure data security and accessibility.

11.0 REFERENCES

- National Institute for Occupational Safety (NIOSH). 2021. NIOSH Pocket Guide to Chemical Hazards, Recommended Exposure Limits. [Cdc.gov/niosh/npg/default.html](https://www.cdc.gov/niosh/npg/default.html)
- NIOSH. 2003. “Elements by ICP.” NIOSH Manual of Analytical Methods (NMAM), Fourth Edition.
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- U.S. EPA. 2020. “General Air Monitoring and Sampling Guidelines.” Environmental Response Team. EPA/625/R-96/010b. October.
- U.S. EPA. 1991. “Management of Investigation Derived Waste during Site Inspections.” Office of Emergency and Remedial Response. Washington, D.C. EPA/540/G-91-009. May.
- U.S. EPA. May 2021. EPA Regional Screening Levels. Retrieved June 14, 2021, from <https://www.epa.gov/risk/regional-screening-levels-rsls>

APPENDIX A: FIGURES

1. Site Location Map
2. Site Layout Map
3. Air Monitoring Location Map



Legend



Fire Location



Former Evacuation Radius

Rockton Chemtool Fire ER
Rockton, IL

Figure 1
Site Location Map

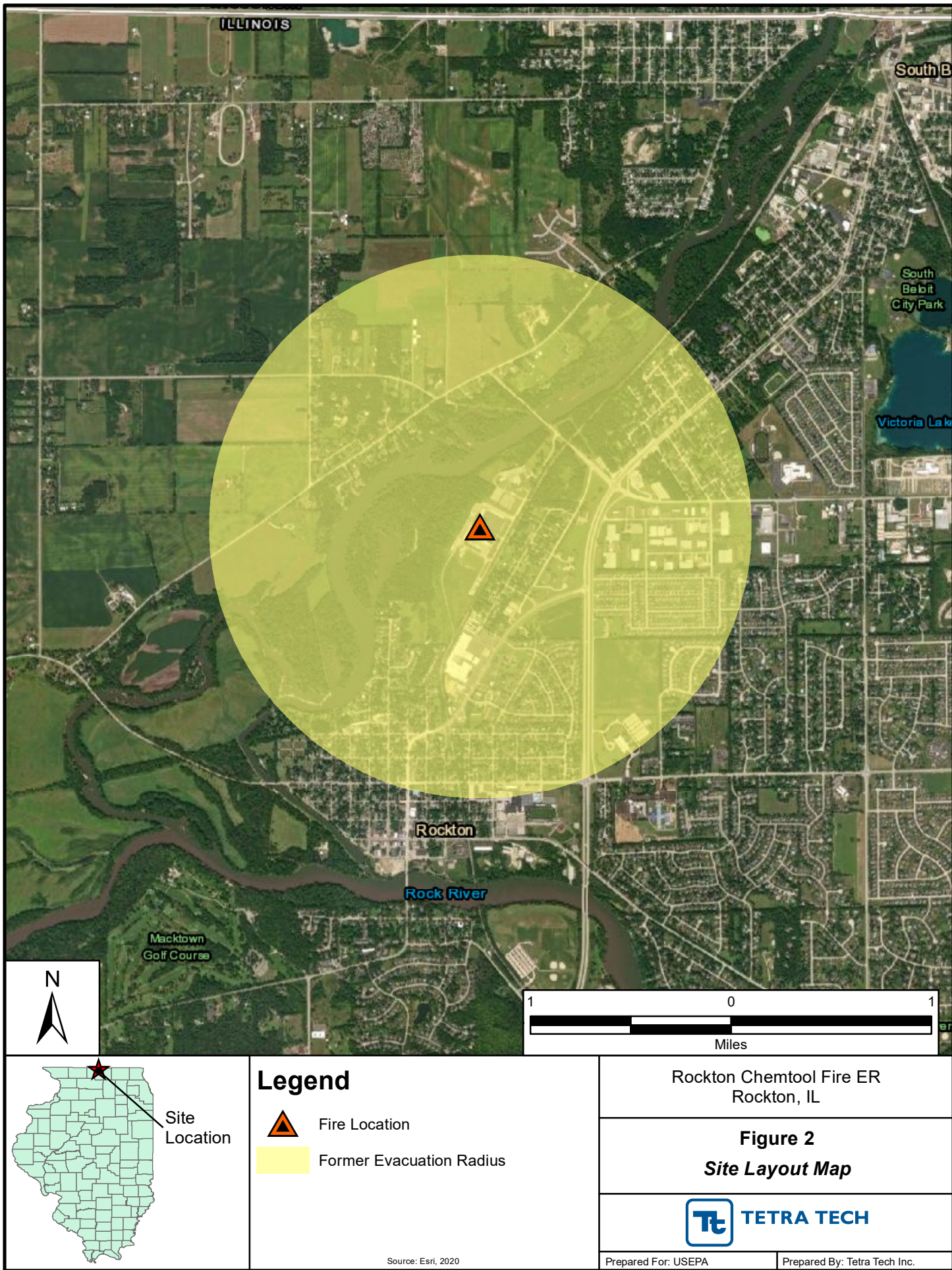


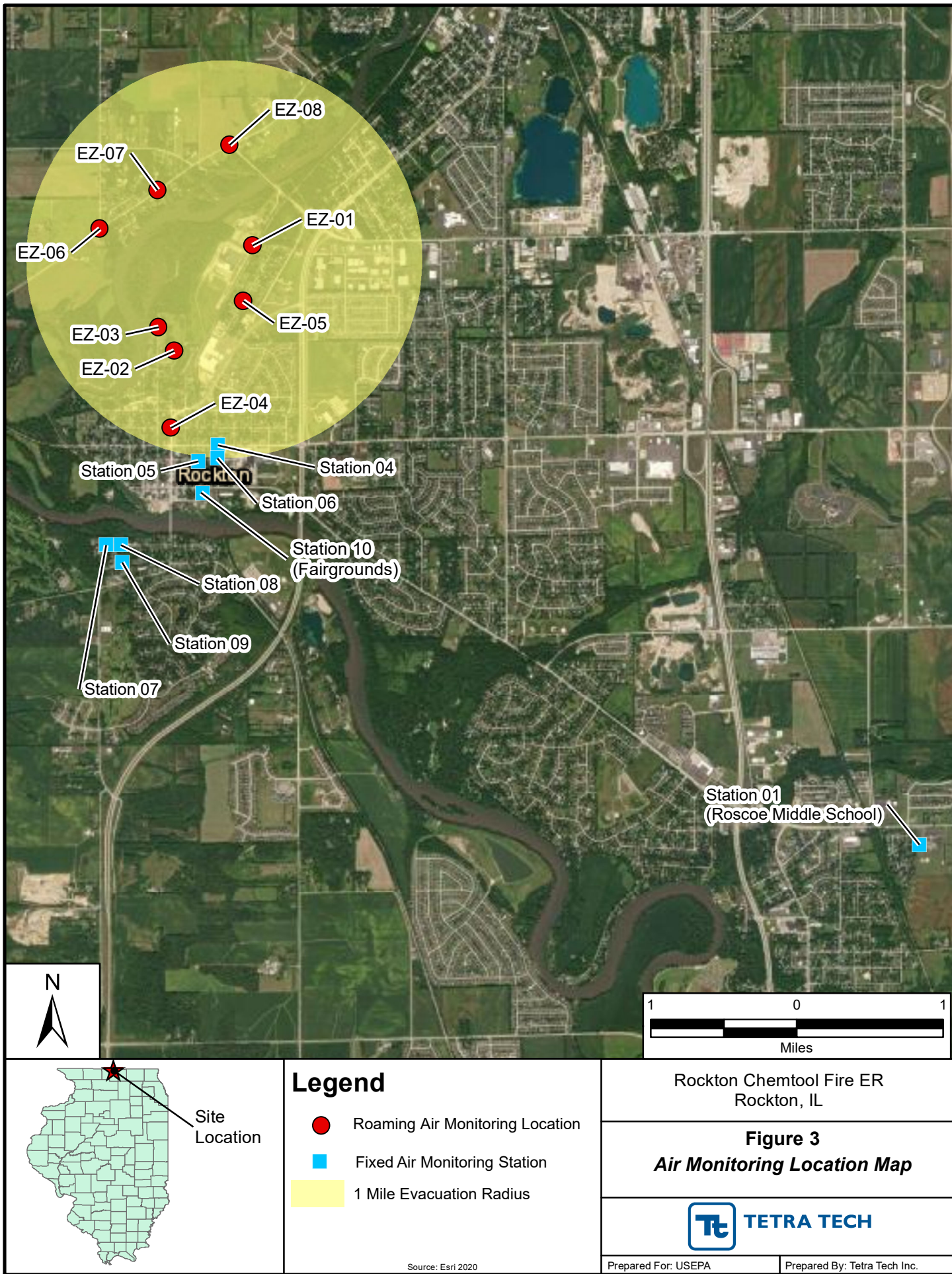
TETRA TECH

Source: USGS 7.5-Minute Quadrangle Topographic Map, South Beloit, IL 2018

Prepared For: USEPA

Prepared By: Tetra Tech Inc.





APPENDIX B: STANDARD OPERATING PROCEDURES

1. EPA Region 4 Science and Ecosystem Support Division Operating Procedure for Management of IDW
2. ERT SOP No. 2008, Revision 0.0 (General Air Sampling Guidelines)
3. EPA SERAS SOP No. 1704 Revision 0.1 (SUMMA Canister Sampling)
4. SOP 002-4 (General Equipment Decontamination)
5. SOP 019-8 (Packaging and Shipping Samples, 2020)
6. SOP 024-3 (Recording of Notes in Field Logbook)
7. SOP 064-1 (Calibration of Air Sampling Pump)
8. SOP 073-2 (Air Quality Monitoring)

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: Management of Investigation Derived Waste

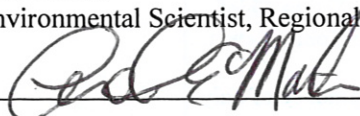
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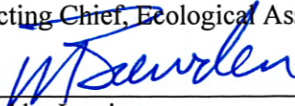
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Revision History

The top row of this table shows the most recent changes to this controlled document. For previous revision history information, archived versions of this document are maintained by the SESD Document Control Coordinator on the SESD local area network (LAN).

History	Effective Date
<p>SESDPROC-202-R3, <i>Management of Investigation Derived Waste</i>, replaces SESDPROC-202-R2.</p> <p>General: Corrected typographical, grammatical and/or editorial errors.</p> <p>Cover Page: The Enforcement and Investigations Branch Chief was changed from Archie Lee to Acting Chief John Deatruck. The Ecological Assessment Branch Chief was changed from Bill Cosgrove to Acting Chief Mike Bowden. The FQM was changed from Liza Montalvo to Bobby Lewis.</p> <p>Revision History: Changes were made to reflect the current practice of only including the most recent changes in the revision history.</p>	July 3, 2014
SESDPROC-202-R2, <i>Management of Investigation Derived Waste</i> , replaces SESDPROC-202-R1.	October 15, 2010
SESDPROC-202-R1, <i>Management of Investigation Derived Waste</i> , replaces SESDPROC-202-R0.	November 1, 2007
SESDPROC-202-R0, Management of Investigation Derived Waste, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes general and specific procedures and considerations to be used and observed when managing investigation derived waste (IDW) generated during the course of hazardous waste site investigations.

1.2 Scope/Application

The procedures and management options for the different categories of IDW described in this document are to be used by SESD field personnel to manage IDW generated during site investigations. On the occasion that SESD field personnel determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used to manage IDW generated at a particular site, the variant procedure will be documented in the field logbook, along with a description of the circumstances requiring its use. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD Local Area Network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when managing IDW. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when managing IDW:

- Due to time limitations and restrictions posed by RCRA regulations on storage of hazardous waste, accumulation start dates should be identified on all drums, buckets or other containers used to hold IDW so that it can be managed in a timely manner.
- During generation of both non-hazardous and hazardous IDW, keep hazardous IDW segregated from non-hazardous IDW to minimize the volume of hazardous IDW that must be properly managed.

2 Types of Investigation Derived Waste

Materials which may become IDW include, but are not limited to:

- Personal protective equipment (PPE) - This includes disposable coveralls, gloves, booties, respirator canisters, splash suits, etc.
- Disposable equipment and items - This includes plastic ground and equipment covers, aluminum foil, conduit pipe, composite liquid waste samplers (COLIWASAs), Teflon® tubing, broken or unused sample containers, sample container boxes, tape, etc.
- Soil cuttings from drilling or hand augering.
- Drilling mud or water used for mud or water rotary drilling.
- Groundwater obtained through well development or well purging.
- Cleaning fluids such as spent solvents and wash water.
- Packing and shipping materials.

Table 1, found at the end of this procedure, lists the types of IDW commonly generated during field investigations and the current disposal practices for these materials.

For the purpose of determining the ultimate disposition of IDW, it is typically distinguished as being either hazardous or non-hazardous. This determination is based on either clear regulatory guidance or by subsequent analysis. This determination and subsequent management is the responsibility of the program site manager.

3 Management of Non-Hazardous IDW

Disposal of non-hazardous IDW should be addressed in the study plan or QAPP for the investigation. To reduce the volume of any IDW transported back to the Field Equipment Center (FEC), it may be necessary to compact the waste into a reusable container, such as a 55-gallon drum.

If the waste is from an active facility, permission should be sought from the operator of the facility to place the non-hazardous PPE, disposable equipment, and/or paper/cardboard into the facility's dumpsters. If necessary, these materials may be placed into municipal dumpsters, with the permission of the owner. These materials may also be taken to a nearby permitted landfill. On larger studies, waste hauling services may be obtained and a dumpster located at the study site.

Disposal of non-hazardous IDW such as drill cuttings, drilling mud, purge or development water, decontamination wash water, etc., should be specified in the approved study plan or QAPP. It is recommended that these materials be placed into a unit with an environmental permit, such as a landfill or sanitary sewer. These materials must not be placed into dumpsters. If the facility at which the study is being conducted is active, permission should be sought to place these types of IDW into the facility's treatment system. It may be feasible to spread drill cuttings around the borehole, or, if the well is temporary, to place the cuttings back into the borehole. Non-hazardous monitoring well purge or development water may also be poured onto the ground down gradient of the monitoring well when site conditions permit. Purge water from private potable wells which are in service may be discharged directly onto the ground surface.

The minimum requirements for this subsection are:

- Non-hazardous liquid and soil/sediment IDW may be placed on the ground or returned to the source if doing so does not endanger human health or the environment or violate federal or state regulations. Under no circumstances, however, should monitoring well purge water be placed back into the well from which it came.
- Soap and water decontamination fluids and rinsates of such cannot be placed in any water bodies and must be collected and returned to the FEC for disposition.
- The collection, handling and proposed disposal method must be specified in the approved study plan or QAPP.

4 Management of Hazardous IDW

Disposal of hazardous or suspected hazardous IDW must be specified in the approved study plan or QAPP for the study or investigation. Hazardous IDW must be disposed as specified in USEPA regulations. If appropriate, these wastes may be placed back in an active facility waste treatment system. These wastes may also be disposed in the source area from which they originated if doing so does not endanger human health or the environment.

If on-site disposal is not feasible, and if the wastes are suspected to be hazardous, appropriate tests must be conducted to make that determination. If they are determined to be hazardous wastes, they must be properly contained and labeled. They may be stored on the site for a maximum of 90 days before they must be manifested and shipped to a permitted treatment or disposal facility. Generation of hazardous IDW must be anticipated, if possible, to allow arrangements for proper containerization, labeling, transportation and disposal/treatment in accordance with USEPA regulations.

The generation of hazardous IDW should be minimized to conserve Division resources. Most routine studies should not produce any hazardous IDW, with the possible exception of spent solvents and, possibly, purged groundwater. The use of solvents during field cleaning of equipment should be minimized by using solvent-free cleaning procedures for routine cleaning and decontamination (see SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205). If solvents are needed, the volume should be minimized by using only the amount necessary and by capturing the residual solvent separately from the aqueous decontamination fluids (detergent/wash water mixes and water rinses).

At a minimum, the requirements of the management of hazardous IDW are as follows:

- Spent solvents must be left on-site with the permission of site operator and proper disposal arranged.
- All hazardous IDW must be containerized. Proper handling and disposal should be arranged prior to commencement of field activities.

Table 1: Disposal of IDW

TYPE	HAZARDOUS	NON - HAZARDOUS
PPE-Disposable	Containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to FEC for disposal in dumpster.
PPE-Reusable	Decontaminate as per SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, if possible. If the equipment cannot be decontaminated, containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	Decontaminate as per SESDPROC-205, and return to FEC.
Spent Solvents	Containerize in original containers. Clearly identify contents. Leave on-site with permission of site operator and arrange for proper disposal.	N/A
Soil Cuttings	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in a 55-gallon steel drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. **
Groundwater	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. **
Decontamination Water	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. Decontamination water may also be disposed in a sanitary sewer system, with permission from the wastewater treatment plant representative, and if doing so does not endanger human health or the environment, or violate federal or state regulations.
Disposable Equipment	Containerize in DOT-approved container or 5-gallon plastic bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. If unfeasible, return to FEC for disposal in dumpster.
Trash	N/A	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to FEC for disposal in dumpster.

**** These materials may be placed on the ground if doing so does not endanger human health or the environment or violate federal or state regulations.**



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1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) provides guidance in developing and implementing sampling plans to assess the impact of hazardous waste sites on ambient air. It presents the United States Environmental Protection Agency/Environmental Response Team's (U.S. EPA/ERT's) approach to air sampling and monitoring and identifies equipment requirements. It is not within the scope of this SOP to provide a generic air sampling plan. Experience, objectives, site characteristics, and chemical characteristics will dictate sampling strategy. This SOP does not address indoor air sampling.

Two basic approaches can be used to assess ambient air (also referred to as air pathway assessments): modeling and measurements. The modeling approach initially estimates or measures the overall site emission rate(s) and pattern(s). These data are input into an appropriate air dispersion model, which predicts either the maximum or average air concentrations at selected locations or distances during the time period of concern. This overall modeling strategy is presented in the first three volumes of the Air Superfund National Technical Guidance Series on Air Pathway Assessments^(1,2,3). Specific applications of this strategy are presented in several additional Air Superfund Technical Guidance documents⁽⁴⁾.

The measurement approach involves actually measuring the air impact at selected locations during specific time periods. These measurements can be used to document actual air impacts during specific time intervals (i.e., during cleanup operations) or to extrapolate the probable "worst case" concentrations at that and similar locations over a longer time period than was sampled.

This SOP addresses issues associated with this second assessment strategy. This SOP also discusses the U.S. EPA/ERT's monitoring instruments, air sampling kits, and approach to air sampling and monitoring at hazardous waste sites.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, depending on site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Air monitoring is defined as the use of direct-reading instruments and other screening or monitoring equipment and techniques that provide instantaneous (real-time) data on the levels of airborne contaminants. The U.S. EPA/ERT maintains numerous monitors for real-time measurements. Examples of air monitoring equipment are hand-held photoionization detectors (PID), flame ionization detectors (FID), oxygen/combustible gas detectors, and remote optical sensors.

Air sampling is defined as those sampling and analytical techniques that require either off- or on-site laboratory analysis and therefore do not provide immediate results. Typically, air sampling occurs after use of real-time air monitoring equipment has narrowed the number of possible contaminants and has provided some qualitative measurement of contaminant concentration. Air sampling techniques are used to more accurately detect, identify and quantify specific chemical compounds relative to the majority of air monitoring technologies.



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In the Superfund Removal Program, On-Scene Coordinators (OSCs) may request the U.S. EPA/ERT to conduct air monitoring and sampling during the following situations: emergency responses, site assessments, and removal activities. Each of these activities has a related air monitoring/sampling objective that is used to determine the potential hazards to workers and/or the community.

- Emergency Response

Emergency responses are immediate responses to a release or threatened release of hazardous substances presenting an imminent danger to public health, welfare, or the environment (i.e., chemical spills, fires, or chemical process failures resulting in a controlled release of hazardous substances). Generally these situations require rapid on-site investigation and response. A major part of this investigation consists of assessing the air impact of these releases.

- Removal Site Assessment

Removal site assessments (referred to as site assessments) are defined as any of several activities undertaken to determine the extent of contamination at a site and which help to formulate the appropriate response to a release or threatened release of hazardous substances. These activities may include a site inspection, multimedia sampling, and other data collection.

- Removal Actions

Removal actions clean up or remove hazardous substances released into the environment. Removal actions include any activity conducted to abate, prevent, minimize, stabilize, or eliminate a threat to public health or welfare, or to the environment.

Personal risk from airborne contaminants can be determined by comparing the results of on-site monitoring and sampling to health-based action levels such as the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs). Residential risk can be determined by comparing the results of off-site monitoring or sampling to health-based action levels such as those developed by the Agency for Toxic Substance and Disease Registry (ATSDR).

The extent to which valid inferences can be drawn from air monitoring/sampling depends on the degree to which the monitoring/sampling effort conforms to the objectives of the event. Meeting the project's objectives requires thorough planning of the monitoring/sampling activities, and implementation of the most appropriate monitoring/sampling and analytical procedures. These issues will be discussed in this SOP.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Preservation, containers, handling and storage for air samples are discussed in the specific SOPs for the technique selected. In addition, the analytical method (i.e., U.S. EPA, National Institute for Occupational Safety and Health [NIOSH], and OSHA Methods) may be consulted for storage temperature, holding times and packaging requirements. After sample collection, the sampling media (i.e., cassettes or tubes) are immediately sealed. The samples are then placed into suitable containers (i.e., whirl bags, resealable bags or culture tubes) which are then placed into a shipping container.



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Use bubble wrap or Styrofoam peanuts when packing air samples for shipment. DO NOT USE VERMICULITE.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Upwind sources can contribute to sample concentration. Natural sources, such as biological waste, can produce hydrogen sulfide and methane which may contribute to the overall contaminant level. Extraneous anthropogenic contaminants (i.e., burning of fossil fuels; emissions from vehicular traffic, especially diesel; and volatile compounds) from petrochemical facilities; effluvium from smoke stacks) may also contribute. Air sampling stations should be strategically placed to identify contributing sources.

Photoreactivity or reaction of the parameters of concern may occur with nonrelated compounds [i.e., nitrogen compounds and polyaromatic hydrocarbons (PAHs)]. Some sorbent media/samples should not be exposed to light during or after sampling due to photochemical effects (i.e., PAHs).

Various environmental factors, including humidity, temperature and pressure, also impact the air sampling methodology, collection efficiency and detection limit. Since the determination of air contaminants is specifically dependent on the collection parameters and efficiencies, the collection procedure is an integral part of the analytical method.

Detection limits depend on the contaminants being investigated and the particular site situation. It is important to know why the data are needed and how the data will be used. Care should be taken to ensure the detection limits are adequate for the intended use of the final results.

Some equipment may be sensitive to humidity and temperature extremes.

5.0 EQUIPMENT/APPARATUS

5.1 Direct Reading Instruments (Air Monitoring Instruments)

There are two general types of direct reading instruments: portable screening devices and specialized analytical instruments. Generally all these techniques involve acquiring, for a specific location or area, continuous or sequential direct air concentrations in either a real-time or semi-real-time mode. None of these instruments acquires true time-weighted average concentrations. In addition, these instruments are not capable of acquiring simultaneous concentration readings at multiple locations, although several are able to sequentially analyze samples taken remotely from different locations. The document, "Guide to Portable Instruments for Assessing Airborne Pollutants Arising from Hazardous Waste Sites⁽⁵⁾," provides additional information about air sampling and monitoring. The hazard levels for airborne contaminants vary. See the ACGIH TLVs and the OSHA PELs for safe working levels. Common screening devices and analytical instruments are described in Appendix A.

5.2 Air Sampling Equipment and Media/Devices

The U.S. EPA/ERT uses the following analytical methods for sampling: *NIOSH Manual of Analytical Methods*⁽⁶⁾, *American Society for Testing and Materials (ASTM) Methods*⁽⁷⁾, *U.S. EPA Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*^(8,9), and *OSHA Methods*⁽¹⁰⁾.



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Additional air sampling references include *Industrial Hygiene and Toxicology* (3rd Ed.)⁽¹¹⁾ and *Air Sampling Instruments for Evaluation of Atmospheric Contaminants*⁽¹²⁾. These methods typically specify equipment requirements for sampling. Since air sampling is such a diverse technology, no single method or reference is best for all applications. Common sampling equipment and media/devices are described in Appendix B.

5.3 Tools/Material and Equipment List

In addition to equipment and materials identified in Appendices A and B, the following equipment and materials may be required to conduct air sampling and monitoring at hazardous waste sites:

- Camera
- Site logbook
- Clipboard
- Chain of custody records
- Custody seals
- Air sampling worksheets
- Sample labels
- Small screwdriver set
- Aluminum foil
- Extension cords
- Glass cracker
- Multiple plug outlet
- Whirl bags or culture tubes
- Teflon tape
- Calibration devices
- Tygon and/or Teflon tubing
- Surgical gloves
- Lint-free gloves
- Ice
- Sample container

Use the following additional equipment when decontaminating glassware on site:

- Protective equipment (i.e., gloves, splash goggles, etc.)
 - Appropriate solvent(s)
 - Spray bottles
 - Liquinox (soap)
 - Paper towels
 - Distilled/deionized water
 - Five-gallon buckets
 - Scrub brushes and bottle brushes

6.0 REAGENTS



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Impinger sampling involves using reagents contained in a glass vial to absorb contaminants of concern (for example, NIOSH Method 3500 for formaldehyde uses 1% sodium bisulfite solution). Impinger solutions vary and are method-dependent.

Reagents such as acetone and hexane are required to decontaminate glassware and some air sampling equipment. Decontamination solutions are specified in ERT/REAC SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURES

7.1 Air Monitoring Design

7.1.1 Initial Surveys

In general, the initial survey is considered to be a relatively rapid screening process for collecting preliminary data at hazardous waste sites. However, initial surveys may require many hours to complete and may consist of more than one entry.

Some information is generally known about the site; therefore, real-time instrumentation for specific compounds (i.e., detector tubes and electrochemical sensors) can be used to identify hot spots. Sufficient data should be obtained with real-time instruments during the initial entry to screen the site for various contaminants. When warranted, intrinsically safe or explosion-proof instruments should be used. An organic vapor analyzer (OVA) is typically used during this survey. These gross measurements may be used on a preliminary basis to (1) determine levels

of personal protection, (2) establish site work zones, and (3) map candidate areas for more thorough qualitative and quantitative studies involving air sampling.

In some situations, the information obtained may be sufficient to preclude additional monitoring. Materials detected during the initial survey may call for a more comprehensive evaluation of hazards and analyses for specific compounds. Since site activities and weather conditions change, a continuous program to monitor the ambient atmosphere must be established.

7.1.2 Off-Site Monitoring

Typically, perimeter monitoring with the same instruments employed for on-site monitoring is utilized to determine site boundaries. Because air is a dynamic matrix, physical boundaries like property lines and fences do not necessarily delineate the site boundary or area influenced by a release. Whenever possible, atmospheric hazards in the areas adjacent to the on-site zone should be monitored with direct-reading instruments. Monitoring at the fenceline or at varying locations off site provides useful information regarding pollutant migration. Three to four locations downwind of the source (i.e., plume) at breathing-zone height provide a basic fingerprint of the plume. Negative instrument readings off site should not be interpreted as the complete absence of airborne toxic substances; rather, they should be considered another piece of information to assist in the preliminary evaluation. The interpretation of negative readings is instrument-



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dependent. The lack of instrument readings off site should not be interpreted as the complete absence of all airborne toxic substances; rather, it is possible that the particular compound or class of compounds to which the monitoring instrument responds is not present or that the concentration of the compound(s) is below the instrument's detection limit.

7.2 Air Sampling Design

7.2.1 Sampling Plan Design

The goal of air sampling is to accurately assess the impact of a contaminant source(s) on ambient air quality. This impact is expressed in terms of overall average and/or maximum air concentrations for the time period of concern and may be affected by the transport and release of pollutants from both on- and off-site sources. The location of these sources must be taken into account as they impact the selection of sampling locations. Unlike soil and groundwater concentrations, air concentrations at points of interest can easily vary by orders of magnitude over the period of concern. This variability plays a major role in designing an air sampling plan.

Downwind air concentration is determined by the amount of material being released from the site into the air (the emission rate) and by the degree that the contamination is diluted as it is transported. Local meteorology and topography govern downwind dilution. Contaminant emission rates can also be heavily influenced by on-site meteorology and on-site activities. All of these concerns must be incorporated into an air sampling plan.

A sampling strategy can be simple or complex, depending on the sampling program objectives. Programs involving characterization of the pollutant contribution from a single point source tend to be simple, whereas sampling programs investigating fate and transport characteristics of components from diverse sources require a more complex sampling strategy. In addition, resource constraints may affect the complexity of the sampling design.

An optimal sampling strategy accounts for the following site parameters:

- Location of stationary as well as mobile sources
- Analytes of concern
- Analytical detection limit to be achieved
- Rate of release and transport of pollutants from sources
- Availability of space and utilities for operating sampling equipment
- Meteorological monitoring data
- Meteorological conditions in which sampling is to be conducted

The sampling strategy typically requires that the concentration of contaminants at the source or area of concern as well as background contributions be quantified. It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks, as well as various other types of QA/QC samples, can be utilized to determine other sources. The impact of extraneous sources on sampling results can frequently be accounted for by



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placing samplers upwind, downwind and crosswind from the subject source. The analytical data from these different sampling locations may be compared to determine statistical differences.

7.2.2 Sampling Objectives

The objectives of the sampling must be determined prior to developing the sampling plan. Does the sampling plan verify adequate levels of protection for on-site personnel, or address potential off-site impacts associated with the site or with site activities? In addition, the assumptions associated with the sampling program must be defined. These assumptions include whether the sampling is to take place under "typical," "worst case", or "one-time" conditions. If the conditions present at the time of sampling are different from those assumed during the development of the sampling plan, then quality of the data collected may be affected. The following definitions have been established:

- Typical: routine daily sampling or routine scheduled sampling at pre-established locations.
- Worst case: sampling conducted under the worst meteorological and/or site conditions which would result in elevated ambient concentrations.
- One-time: only one chance is given to collect a sample without regard to time or conditions. Qualitative data acquired under these conditions are usually applicable only to the time period during which the data were collected and may not provide accurate information to be used in estimating the magnitude of an air impact during other periods or over a long time interval.

The sampling objectives also dictate the detection limits. Sampling methods for airborne contaminants will depend upon the nature and state (solid, liquid or gas) of the contaminant. Gases and vapors may be collected in aqueous media or adsorbents, in molecular sieves, or in suitable containers. Particulates are collected by filters or impactors. The volume of sample to be collected is dependent upon an estimate of the contaminant concentration in the air, the sensitivity of the analytical method, and the standard or desired detection limit. A sufficient amount of sample must be collected to achieve the desired detection limit without interference from other contaminants. In addition, the selected method must be able to detect the target compound(s).

7.2.3 Location and Number of Individual Sampling Points

Choose the number and location of sampling points according to the variability, or sensitivity, of the sampling and analytical methods being utilized, the variability of contaminant concentration over time at the site, the level of precision required and cost limitations. In addition, determine the number of locations and placement of samplers by considering the nature of the response, local terrain, meteorological conditions, location of the site (with respect to other conflicting background sources), size of the site, and the number, size, and relative proximity of separate on-site emission sources and upwind sources. The following are several considerations for sampler placement:



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- Location of potential on-site emission sources, as identified from the review of site background information or from preliminary on-site inspections.
- Location of potential off-site emission sources upwind of the sampling location(s). Review local wind patterns to determine the location of off-site sources relative to wind direction.
- Topographic features that affect the dispersion and transport of airborne toxic constituents. Avoid natural obstructions when choosing air sampling station locations, and account for channelization around those obstructions.
- Large water bodies, which affect atmospheric stability and the dispersion of air contaminants.
- Roadways (dirt or paved), which may generate dust that could mask site contaminants.
- Vegetation, such as trees and shrubs, which stabilizes soil and retards subsurface contaminants from becoming airborne. It also affects air flow and scrubs some contaminants from the air. Sometimes thick vegetation can make an otherwise ideal air monitoring location inaccessible.

Consider the duration of sampling activities when choosing the location and number of samples to be collected. For example, if the sampling period is limited to a few hours, one or two upwind and several downwind samples would typically be adequate, especially around major emission sources.

A short-term monitoring program ranges from several days to a few weeks and generally includes gathering data for site assessments, removal actions, and source determination data (for further modeling). Activities involved in a short-term sampling strategy must make the most of the limited possibilities for data collection. Consider moving upwind/downwind locations daily based on National Oceanic and Atmospheric Administration (NOAA) weather forecasts. Weather monitoring becomes critical where complex terrain and local meteorological effects frequently change wind direction. Often, a number of alternatives can fulfill the same objective.

Prevailing winds running the length of a valley usually require a minimum number of sampler locations; however, a complex valley may require more sampler locations to account for the wide variety of winds. Ocean/lake effects may require a radical plan to collect enough samples to reach a low detection limit. Two sets of samplers may be placed next to each other: one set would be activated during the sea breeze while the other set is turned off, and vice versa when there is no sea breeze. After the sampling event, the respective upwind and downwind samples would be combined. Another alternative for sampling near a large body of water may be to use automatic, wind-vector-operated samplers, which turn the sampler on only when the wind comes from a specified vector. At sites located on hillsides, wind will move down a valley and produce an upward fetch at the same time. Sampling locations may have to ring the site to measure



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the wind's impact.

Off-site sources may affect on-site monitoring. In this case, on-site meteorological data, concurrent with sampling data, is essential to interpreting the acquired data. Also, additional upwind sampling sites may be needed to fully characterize ambient background contaminant levels. Multiple off-site sources may require several monitoring locations, but if the sources are at a sufficient distance, only one monitoring location is needed.

Topography and weather are not the only factors in sampler location; the sampling sites must be secure from vandals and mishap. Secure all sampling locations to maintain chain of custody, and to prevent tampering with samples or loss of sampling units. High-volume sampling methods often require the use of 110 VAC electric power. When portable generators are used, the power quality may affect sampler operation. Also, be aware that the generators themselves could be a potential pollution source if their placement is not carefully considered.

Air quality dispersion models can be used to place samplers. The models incorporate source information, surrounding topography, and meteorological data to predict the general distance and directions of maximum ambient concentrations. Modeling results should be used to select sampling locations in areas of maximum pollutant concentrations.

7.2.4 Time, Duration and Frequency of Sampling Events

After choosing appropriate sampling or monitoring locations, determine the sampling frequency and the number of samples to be collected. The time of day, duration and frequency of sampling events is governed by:

- The effects of site activities and meteorology on emission rates
- The diurnal effect of the meteorology on downwind dispersion
- The time period(s) of concern as defined by the objective
- The variability in the impact from other non-site-related sources
- If defined, the degree of confidence needed for either the mean or maximum downwind concentrations observed
- The precision requirements for single measurements
- Cost and other logistical considerations

The duration of the removal action and the number of hours per day that site work is conducted determine the time, duration, and frequency of samples. Short-term sampling programs may require daily sampling, while long-term programs may require 24-hour sampling every sixth or twelfth day. If the site will be undergoing removal activities 24 hours a day, continuous air sampling may be warranted. However, if the site activities will be conducted for only eight hours a day, and there are no emissions likely to occur during the remaining 16 hours, then sampling would be appropriate prior to the start of daily activities, would continue during operations, and end at the conclusion of the daily activities. An off-peak sample collection can ensure that emissions are not persisting



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after the conclusion of daily cleanup activities. For some sites, emissions are still a factor several hours after daily site activities have been completed. Because of the typically decreased downwind dispersion in the evening, higher downwind concentrations than were present during daytime site activities may be detected. For sites where this is possible, the sampling duration needs to be lengthened accordingly.

Sampling duration and flow rate dictate the volume of air collected, and to a major degree, the detection limit. The analytical method selected will provide a reference to flow rate and volume. Flow rates are limited to the capacity of the pumps being employed and the contact time required by the collection media.

The duration or period of air sampling is commonly divided into two categories (1) samples collected over a brief time period are referred to as "instantaneous" or "grab" samples and are usually collected in less than five minutes and (2) average or integrated samples are collected over a significantly longer period of time. Integrated samples provide an average concentration over the entire sampling period. Integrated samples are not suited to determining cyclical releases of contaminants because periodic or cyclical events are averaged out by the proportionally long sampling duration.

Air quality dispersion models can predict the maximum air contaminant concentration expected from a source. The meteorological and site conditions expected to cause the highest concentration are known as worst-case conditions and can be identified by analyzing the modeling results. Depending upon the objective, one may sample when the model predicts worst-case conditions will exist.

7.2.5 Meteorological and Physical/Chemical Considerations

A meteorological monitoring program is an integral part of site monitoring activities. Meteorological data, which define local terrain impacts on air flow paths, are needed to interpret air concentration data. Meteorological data may be available from an existing station located near the site (i.e., at a local airport), otherwise a station should be set up at the site. This data will document the degree that samples actually were downwind and verify whether other worst-case assumptions were met. Meteorological parameters to be monitored are, at a minimum, wind speed, wind direction, and sigma theta (which is the horizontal wind direction standard deviation and an indicator of atmospheric stability). The remaining parameters primarily affect the amount of a contaminant available in the air.

- Wind Speed

When the contaminant of concern is a particulate, wind speed is critical in determining whether the particulate will become airborne, the quantity of the particulate that becomes airborne, and the distance the particulate will travel from the source. Wind speed also contributes to the volatilization of contaminants from liquid sources.

- Wind Direction



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Wind direction highly influences the path of airborne contaminants. In addition, variations in wind direction increase the dispersion of pollutants from a given source.

- Atmospheric Stability

Atmospheric stability refers to the degree to which the atmosphere tends to dampen vertical and horizontal motion. Stable atmospheric conditions (i.e., evenings) result in low dispersion, and unstable atmospheric conditions (i.e., hot sunny days) result in higher dispersion.

- Temperature

Higher temperatures increase the rate of volatilization of organic and some inorganic compounds and affect the initial rise of gaseous or vapor contaminants. Therefore, worst-case emission of volatiles and semivolatiles occurs at the hottest time of day, or on the hottest day.

- Humidity

High humidity affects water-soluble chemicals and particulates. Humid conditions may dictate the sampling media used to collect the air sample, or limit the volume of air sampled and thereby increase the detection limit.

- Atmospheric Pressure

Migration of landfill gases through the landfill surface and through surrounding soils are governed by changes in atmospheric pressure. Atmospheric pressure will influence upward migration of gaseous contaminants from shallow aquifers into the basements of overlying structures.

In many cases, the transport and dispersion of air pollutants is complicated by local meteorology. Normal diurnal variations (i.e., temperature inversions) affect dispersion of airborne contaminants. Terrain features can enhance or create air inversions and can also influence the path and speed of air flow, complicating transport and dispersion patterns.

The chemical characteristics of a contaminant (i.e., molecular weight, physical state, vapor pressure, aerodynamic size, temperature, reactive compounds, and photodegradation) affects its behavior and can influence the method used to sample and analyze it.

8.0 CALCULATIONS

Volume is obtained by multiplying the sample time in minutes by the flow rate. Sample volume should be indicated on the chain of custody record. Adjustments for temperature and pressure differences may be required.

Results are usually provided in parts per million (ppm), parts per billion (ppb), milligrams per cubic meter



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(mg/m³) or micrograms per cubic meter (µg/m³).

Refer to the analytical method or regulatory guidelines for other applicable calculations.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The manufacturer's instructions should be reviewed prior to instrument use. Instruments must be utilized in accordance with manufacturer's instructions. Equipment checkout and calibration activities must occur prior to and after monitoring and sampling and must be documented.

9.1 QA/QC Samples

QA/QC samples provide information on the variability and usability of environmental sample results. Various QA/QC samples may be collected to detect error. QA/QC samples are submitted with the field samples for analysis to aid in identifying the origin of analytical discrepancies; then a determination can be made as to how the analytical results should be used. Collocated samples, background samples, field blanks, and lot blanks are the most commonly collected QA/QC field samples. Performance evaluation (PE) samples and matrix spikes provide additional measures of data QA/QC control. QA/QC results may suggest the need for modifying sample collection, preparation, handling, or analytical procedures if the resultant data do not meet site-specific QA or data quality objectives. Refer to ERT/REAC SOP #2005, Quality Assurance/Quality Control Samples, for further details, and suggested frequencies for submittal of QA/QC samples.

9.2 Sample Documentation

All sample and monitoring activities should be documented legibly, in ink. Any corrections or revisions should be made by lining through the incorrect entry and by initialing the error. All samples must be recorded on an Air Sampling Worksheet. A chain of custody record must be maintained from the time a sample is taken to the final deposition of the sample. Custody seals demonstrate that a sample container has not been opened or tampered with during transport or storage of samples. Refer to ERT/REAC SOP #2002, Sample Documentation, for further information.

10.0 DATA VALIDATION

Results for QA/QC samples should be evaluated for contamination. This information should be utilized to qualify the environmental sample results accordingly with data quality objectives.

11.0 HEALTH AND SAFETY

Personal protection equipment (PPE) requirements identified in federal and/or state regulations and 29 Code of Federal Regulations (CFR) 1910.120 for hazardous waste site work must be followed.

The majority of physical precautions involved in air sampling are related to the contaminant sampled. Attention should be given when sampling in potentially explosive, flammable or acidic atmospheres. On rare occasions, the collection media may be hazardous; for example, in the instance where an acidic or basic solution is utilized in an impinger.



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When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

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- (10) OSHA. *Analytical Methods Manual, Second Edition. Part 1, Organic Substances*, January 1990. *Part 2, Inorganic Substances* August 1991.
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Emergency Response Division, Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, April 1992, Interim Final.



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APPENDIX A
Portable Screening Devices and Specialized Analytical Instruments
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PORTABLE SCREENING DEVICES

Where possible, a datalogger should be used to minimize the length of time required for site personnel to be in a potentially contaminated area. Datalogger cable is available from manufacturers for linear output instruments and some nonlinear output instruments. U.S. EPA ERT/REAC has output cables for organic vapor analyzers (i.e., HNU and OVA), toxic gas analyzers (i.e., monitox) and real-time aerosol monitors (i.e., RAM and miniram).

- Total Hydrocarbon Analyzers

Total hydrocarbon analyzers used to detect a variety of volatile organic compounds (VOCs) at hazardous waste sites principally employ either a photoionization detector (PID) or a flame ionization detector (FID). Compounds are ionized by a flame or an ultraviolet lamp. PIDs depend on the ionization potential of the compounds. PIDs are sensitive to aromatic and olefinic (unsaturated) compounds such as benzene, toluene, styrene, xylenes, and acetylene. Greater selectivity is possible by using low-voltage lamps. The ionization potential of individual compounds can be found in the NIOSH Pocket Guide to Chemical Hazards. These instruments are not compound-specific and are typically used as screening instruments. FIDs are sensitive to volatile organic vapor compounds such as methane, propanol, benzene and toluene. They respond poorly to organic compounds lacking hydrocarbon characteristics.

- Oxygen and Combustible Gas Indicators

Combustible Gas Indicators (CGIs) provide efficient and reliable methods to test for potentially explosive atmospheres. CGI meters measure the concentration of a flammable vapor or gas in air and present these measurements as a percentage of the lower explosive limit (LEL). The measurements are temperature-dependent. The property of the calibration gas determines sensitivity. LELs for individual compounds can be found in the NIOSH Pocket Guide to Chemical Hazards. If readings approach or exceed 10% of the LEL, extreme caution should be exercised in continuing the investigation. If readings approach or exceed 25% LEL, personnel should be withdrawn immediately.

CGIs typically house an electrochemical sensor to determine the oxygen concentration in ambient air. Normally, air contains approximately 20.9% oxygen by volume. Oxygen measurements are of particular importance for work in enclosed spaces, low-lying areas, or in the vicinity of accidents that have produced heavier-than-air vapors which could displace ambient air. The meters are calibrated for sea level and may indicate a false negative (i.e., O₂ content) at higher altitudes. Since the air has been displaced by other substances, these oxygen-deficient areas are also prime locations for taking additional organic vapor and combustible gas measurements. Oxygen-enriched atmospheres increase the potential for fires by their ability to contribute to combustion or to chemically react with flammable compounds and promote auto-ignition.

- Toxic Atmosphere Analyzers

The toxic atmosphere analyzer is a compound-specific instrument, designed and calibrated to identify and quantify a specific compound or class of compounds in either gaseous or vapor form. Cross-sensitivity to air pollutants not of interest may lead to erroneous results.

U.S. EPA/ERT has the following toxic atmosphere analyzers: carbon monoxide, phosgene, nitrous oxide, hydrogen cyanide, sulfur dioxide, hydrogen sulfide, and chlorine gas.



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- Aerosol/Particulate Monitors

A Real-Time Aerosol/Particulate Monitor (RAM) displays readings for total particulates. The instrument employs a pulse light emitting diode which generates a narrow band emission in conjunction with a photovoltaic cell to detect light scattered from particulates.

The U.S. EPA/ERT uses the RAM when the contaminant of concern is associated with particulates, and when responding to fires involving hazardous materials, to identify plume levels. The instrument is very useful in determining the presence of a plume when it is not visible. The U.S. EPA/ERT typically uses RAMs on tripods to obtain particulate concentrations at the breathing zone level. Personal dataloggers are used with the RAMs to document minimum, average and maximum concentrations. This provides real-time data without requiring those in personal protective equipment to be constantly present in the plume.

- Chemical Detector Tubes (Colorimetric Tubes)

A chemical detector tube is a hollow, tube-shaped, glass body containing one or more layers of chemically impregnated inert material. To use, the fused ends are broken off and a manufacturer-specified volume of air is drawn through the tube with a pump to achieve a given detection limit. The chemicals contained within the packing material undergo a chemical reaction with the airborne pollutant present, producing a color change during the intake of each pump stroke. The concentration of a pollutant is indicated by the length of discoloration on a calibrated scale printed on the detector tube.

- Radiation Meters

Radiation meters determine the presence and level of radiation. The meters use a gas or solid ion detection media which becomes ionized when radiation is present. The meters are normally calibrated to one probe. Meters that detect alpha, beta, and gamma radiation are available.

- Gold Film (Hydrogen Sulfide and Mercury Vapor) Monitors

Hydrogen sulfide (H_2S) and Mercury (Hg) monitors operate on the principle that electric resistivity increases across a gold film as a function of H_2S and Hg concentration. The monitors provide rapid and relatively low detection limits for H_2S and Hg in air. After extensive sampling periods or high concentrations of H_2S and Hg , the gold film must be heated to remove contamination and return the monitor to its original sensitivity.

- Infrared Detectors

Infrared detectors such as the Miniature Infrared Analyzer (MIRAN) use infrared (IR) absorption as a function of specific compounds. MIRAN instruments apply to situations where the contaminants are identified but concentrations are not. MIRAN instruments generally require AC power.



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SPECIALIZED ANALYTICAL INSTRUMENTS

The continuous monitors described above provide qualitative measurement of air contaminants. Quantitative measurements in the field can be obtained using more sophisticated instruments, such as portable Gas Chromatographs, to analyze grab samples.

- Direct Air Sampling Portable Gas Chromatographs (GCs)

Portable GCs use gas chromatography to identify and quantify compounds. The time it takes for a compound to move through a chromatographic column is a function of that specific compound or group of compounds. A trained technician with knowledge of the range of expected concentrations of compounds can utilize a portable GC in the field to analyze grab samples. GCs generally require AC power and shelter to operate. This method is limited by its reliance on a short-term grab sample to be representative of the air quality at a site.

- Remote Optical Sensing

This technique, also referred to as long-path or open-path monitoring, involves transmitting either an infrared or ultraviolet light beam across a long open path and measuring the absorbance at specific wavelengths. The technique is capable of analyzing any preselected organic or inorganic volatile compound that can be resolved from compounds naturally occurring in ambient air. Current projected removal applications include perimeter monitoring during site cleanups and measurement of emission source strengths during site assessments.

- TAGA Direct Air Sampling Mass Spectrometer/Mass Spectrometer

The Trace Atmospheric Gas Analyzer (TAGA), which is operated by the U.S. EPA/ERT, is capable of real-time detection of preselected organic compounds at low parts-per-billion concentrations. The instrument has been successfully used by the U.S. EPA/ERT for isolating individual emission plumes and tracking those plumes back to their sources.



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APPENDIX B
Air Sampling Equipment and Media/Devices
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AIR SAMPLING EQUIPMENT

- High-Volume, Total Suspended Particulate (TSP) Samplers

High-volume TSP samplers collect all suspended particles by drawing air across an 8- by 10-inch glass-quartz filter. The sample rate is adjusted to 40 cubic feet per minute (CFM), or 1134 liters per minute (L/min), and it is held constant by a flow controller over the sample period. The mass of TSPs can be determined by weighing the filter before and after sampling. The composition of the filter varies according to the analytical method and the detection limit required.

- PM-10 Samplers

PM-10 samplers collect particulates with a diameter of 10 microns or less from ambient air. Particulates of this size represent the respirable fraction, and thus are of special significance. PM-10 samplers can be high-volume or low-volume. The high-volume sampler operates in the same manner as the TSP sampler at a constant flow rate of 40 CFM; it draws the sample through a special impactor head which collects particulates of 10 microns or less. The particulate is collected on an 8- by 10-inch filter. The low-volume sampler operates at a rate of approximately 17 L/min. The flow must remain constant through the impactor head to maintain the 10-micron cut-off point. The low-volume PM-10 collects the sample on 37-mm Teflon® filters.

- High-Volume PS-1 Samplers

High-volume PS-1 samplers draw a sample through polyurethane foam (PUF) or a combination foam and XAD-2 resin plug, and a glass quartz filter at a rate of 5-10 CFM (144 to 282 L/min). This system is excellent for measuring low concentrations of semivolatiles, PCBs, pesticides, or chlorinated dioxins in ambient air.

- Area Sampling Pumps

These pumps provide flow-rate ranges of 2-20 L/min and have a telescopic sampling mast with the sampling train. Because of the higher volume, this pump is suitable for sampling low concentrations of airborne contaminants (i.e., asbestos sampling). These pumps are also used for metals, pesticides and PAH sampling which require large sample volumes.

- Personal Sampling Pumps

Personal sampling pumps are reliable portable sampling devices that draw air samples through a number of sampling media including resin tubes, impingers, and filters. Flow rates are usually adjustable from 0.1 to 4 L/min (or 0.01 to .75 L/min with a restrictive orifice) and can remain constant for up to 8 hours on one battery charge or continuously with an AC charger/converter.

- Canister Samplers

Evacuated canister sampling systems use the pressure differential between the evacuated canister and ambient pressure to bleed air into the canister. The sample is bled into the canister at a constant rate over



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the sampling period using a critical orifice, a mechanically compensated regulator, or a mass flow control device until the canister is near atmospheric pressure.

Pressure canister sampling systems use a pump to push air into the canister. To maintain a higher, more controlled flow, the pump typically controls the pressure differential across a critical orifice at the inlet of the canister, resulting in a pressurized canister at the completion of sampling.



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AIR SAMPLING MEDIA/DEVICES

If possible, before employing a specific sampling method, consult the laboratory that will conduct the analyses. Many of the methods can be modified to provide better results or a wider range of results.

- Summa Canisters

Summa canisters are highly polished passivated stainless steel cylinders. The Summa polishing process brings chrome and nickel to the surface of the canisters, which results in an inert surface. This surface restricts adsorption or reactions that occur on the canister's inner surface after collection. At the site, the canister is either placed in a sampler to control sample collection rate, or opened to collect a grab sample. Samples can be collected by allowing air to bleed into or be pumped into the canister. U.S. EPA/ERT uses 6-liter Summa canisters for VOC and permanent gas analysis.

- Passive Dosimeters

Passive dosimeters are clip-on vapor monitors (samplers) in which the diffused contaminants are absorbed on specially prepared active surfaces. Industrial hygienists commonly use dosimeters to obtain time-weighted averages or concentrations of chemical vapors, as they can trap over 130 organic compounds. Selective dosimeters have also been developed for a number of chemicals including formaldehyde, ethylene oxide, hydrogen sulfide, mercury vapor, nitrogen dioxide, sulfur dioxide, and ozone. Dosimeters must be sent to a laboratory for analysis.

- Polyurethane Foam (PUF)

PUF is a sorbent used with a glass filter for the collection of semivolatile organic compounds such as pesticides, PCBs, chlorinated dioxins and furans, and PAHs. Fewer artifacts (chemical changes that occur to collected compounds) are produced than with some other solid sorbents. PUF is used with the PS-1 sampler and U.S. EPA Method TO13. PUF can also be used with personal sampling pumps when sampling for PAHs using the Lewis/McCloud method. Breakthrough of the more volatile PCBs and PAHs may occur when using PUF.

- Sampling Bags (Tedlar)

Sampling bags, like canisters, transport air samples to the laboratory for analysis. Samples are generally pumped into the bags, but sometimes a lung system is used, in which a pump creates a vacuum around the bag in a vacuum box. Then the sample flows from a source into the bag. This method is used for VOCs, fixed gases (CO_2 , O_2 and N_2) and methane.

- Impingers

An impinger allows an air sample to be bubbled through a solution, which collects a specific contaminant by either chemical reaction or absorption. For long sampling periods, the impinger may need to be kept in an ice bath to prevent the solution from evaporating during sampling. The sample is drawn through the impinger by using a sampling pump or more elaborate sampling trains with multiple impingers.

- Sorbent Tubes/Cartridges



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A variety of sampling media are available in sorbent tubes, which are used primarily for industrial hygiene. A few examples are carbon cartridges, carbon molecular sieves, Tenax tubes and tube containing the XAD-2 polymer. Depending upon the sorbent material, tubes can be analyzed using either a solvent extraction or thermal desorption. The former technique uses standard laboratory equipment and allows for multiple analyses of the same sample. The latter technique requires special, but readily available, laboratory equipment and allows only one analysis per sample. In addition, thermal desorption typically allows for lower detection limits by two or more orders of magnitude. Whenever sorbent tubes are being used for thermal desorption, they should be certified as "clean" by the laboratory doing the analysis.

Thermally Desorbed Media

During thermal desorption, high-temperature gas streams are used to remove the compounds collected on a sorbent medium. The gas stream is injected and often cryofocused into an analytical instrument, such as a GC, for compound analysis:

- Tenax Tubes

Tenax tubes are made from commercially available polymer (p-phenylene oxide) packed in glass or stainless steel tubes through which air samples are drawn or sometimes pumped. These tubes are used in U.S. EPA Method TO1 and VOST for volatile nonpolar organic, some polar organic, and some of the more volatile semivolatile organics. Tenax is not appropriate for many of the highly volatile organics (with vapor pressure greater than approximately 200 mm Hg).

- Carbonized Polymers

The carbonized molecular sieve (CMS), a carbonized polymer, is a commercially available, carbon sorbent packed in stainless-steel sampling tubes through which air samples are drawn or sometimes pumped. These are used in U.S. EPA Method TO2 for highly volatile nonpolar compounds which have low-breakthrough volumes on other sorbents. When high-thermal desorption temperatures are used with CMS, more variability in analysis may occur than with other sorbents.

- Mixed Sorbent Tubes

Sorbent tubes can contain two type of sorbents. Combining the advantages of each sorbent into one tube increases the possible types of compounds to be sampled. The combination of two sorbents can also reduce the chance that highly volatile compounds will break through the sorbent media. An example of a mixed sorbent tube is the combination of Tenax and charcoal with a carbonized molecular sieve. A potential problem with mixed sorbent tubes is the breakthrough of a compound from an earlier sorbent to a later sorbent from which it cannot be desorbed.

Solvent-Extracted Media

Solvent-extracted media use the principle of chemical extraction to remove compounds collected on a sorbent media. The chemical solvent is injected into an instrument, such as a GC, for analysis of compounds. Examples of solvent-extracted media follow:

- Chemically Treated Silica Gel



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Silica gel is a sorbent which can be treated with various chemicals. The chemically treated silica gel can then be used to sample for specific compounds in air. Examples include the DNPH-coated silica gel cartridge used with U.S. EPA Method TO11.

- XAD-2 Polymers

XAD-2 polymers usually are placed in tubes, custom-packed sandwich-style with polyurethane foam, and prepared for use with U.S. EPA Method TO13 or the semi-VOST method. The polymers are used for the collection of semivolatile polar and nonpolar organic compounds. The compounds collected on the XAD-2 polymer are chemically extracted for analysis.

- Charcoal Cartridges

Charcoal cartridges, consisting of primary and backup sections, trap compounds by adsorption. Ambient air is drawn through them so that the backup section verifies that breakthrough of the analytes on the first section did not occur, and the sample collection was therefore quantitative. Quantitative sample collection is evident by the presence of target chemicals on the first charcoal section and the absence on the second section. Next, the adsorbed compounds must be eluted, usually with a solvent extraction, and analyzed by GC with a detector, such as a Mass Spectrometer (MS).

- Tenax Tubes

Cartridges are used in OSHA and NIOSH methods in a manner similar to charcoal cartridges but typically for less volatile compounds.

- Particulate Filters

Particulate filters are used by having a sampling pump pass air through them. The filter collects the particulates present in the air and is then analyzed for particulate mass or chemical or radiological composition. Particulate filters are made from different materials which are described below.

- Mixed Cellulose Ester (MCE)

MCE is manufactured from mixed esters of cellulose which are a blend of nitro-cellulose and cellulose acetate. MCE filters are used often for particulate sampling.

- Glass Fiber

Glass fiber is manufactured from glass fibers without a binder. Particulate filters with glass fiber provide high flow rates, wet strength, and high, solid holding capacity. Generally, the filters are used for gravimetric analysis of particulates.

- Polyvinyl Chloride

Particulate filters with polyvinyl chloride are resistant to concentrated acids and alkalis. Their low moisture pickup and light tare weight make them ideal for gravimetric analysis.



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- Teflon

Teflon is manufactured from polytetrafluorethylene (PTFE). Particulate filters with Teflon are easy to handle and exceptionally durable. Teflon filters are used for metal collection.

- Silver

Particulate filters manufactured from pure silver have high collection efficiency and uniform pore size. These filters are used for mercury collection and analysis.

- Cellulose

Particulate filters with cellulose contain less than 0.01% ash. These filters are used to collect particulates.



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SUMMA CANISTER SAMPLING

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5.1	Subatmospheric Pressure Sampling Equipment
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* This section affected by Revision 0.1.



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SUPERCEDES: SOP #1704; Revision 0.0; 09/12/94



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1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe a procedure for sampling of volatile organic compounds (VOCs) in ambient air. The method is based on samples collected as whole air samples in Summa passivated stainless steel canisters. The VOCs are subsequently separated by gas chromatography (GC) and measured by mass-selective detector or multidetector techniques. This method presents procedures for sampling into canisters at final pressures both above and below atmospheric pressure (respectively referred to as pressurized and subatmospheric pressure sampling).

This method is applicable to specific VOCs that have been tested and determined to be stable when stored in pressurized and subatmospheric pressure canisters. The organic compounds that have been successfully collected in pressurized canisters by this method are listed in the Volatile Organic Compound Data Sheet (Appendix A). These compounds have been measured at the parts per billion by volume (ppbv) level.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Both subatmospheric pressure and pressurized sampling modes use an initially evacuated canister. Both modes may also use a mass flow controller/vacuum pump arrangement to regulate flow. With the above configuration, a sample of ambient air is drawn through a sampling train comprised of components that regulate the rate and duration of sampling into a pre-evacuated Summa passivated canister. Alternatively, subatmospheric pressure sampling may be performed using a fixed orifice, capillary, or adjustable micrometering valve in lieu of the mass flow controller/vacuum pump arrangement for taking grab samples or short duration time-integrated samples. Usually, the alternative types of flow controllers are appropriate only in situations where screening samples are taken to assess for future sampling activities.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

After the air sample is collected, the canister valve is closed, an identification tag is attached to the canister, and the canister is transported to a laboratory for analysis. Upon receipt at the laboratory, the canister tag data is recorded. Sample holding times and expiration should be determined prior to initiating field activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Contamination may occur in the sampling system if canisters are not properly cleaned before use. Additionally, all other sampling equipment (e.g., pump and flow controllers) should be thoroughly cleaned. Instructions for cleaning the Summa canisters are described in ERT/SERAS SOP #1703, Summa Canister Cleaning Procedures.



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5.0 EQUIPMENT/APPARATUS

The following equipment/apparatus (Figure 1, Appendix B) is required:

5.1 Subatmospheric Pressure Sampling Equipment

1. VOC canister sampler - whole air sampler capable of filling an initially evacuated canister by action of the flow controlled pump from vacuum to near atmospheric pressure. (Andersen Samplers Inc., Model 87-100 or equivalent).
2. Sampling inlet line - stainless steel tubing to connect the sampler to the sample inlet.
3. Sample canister - leak-free stainless steel pressure vessels of desired volume with valve and Summa passivated interior surfaces (Scientific Instrumentation Specialist, Inc., ID 83843, Andersen Samplers, Inc., or equivalent).
4. Particulate matter filter - 2- μ m sintered stainless steel in-line filter (Nupro Co., Model SS-2F-K4-2, or equivalent).
5. Chromatographic grade stainless steel tubing and fittings - for interconnections (Alltech Associates, Cat. # 8125, or equivalent). All materials in contact with sample, analyte, and support gases should be chromatographic grade stainless steel.
6. Fixed orifice, capillary, or adjustable micrometering valve - used in lieu of the electronic flow controller/vacuum pump for grab samples or short duration time-integrated samples.

5.2 Pressurized Sampling Equipment

1. VOC canister sampler - whole air sampler capable of filling an initially evacuated canister by action of the flow controlled pump from vacuum to near atmospheric pressure. (Andersen Samplers Inc., Model 87-100).
2. Sampling inlet line - stainless steel tubing to connect the sampler to the sample inlet.
3. Sample canister - leak-free stainless steel pressure vessels of desired volume with valve and Summa passivated interior surfaces (Scientific Instrumentation Specialist, Inc., ID 83843, Andersen Samplers, Inc., or equivalent).
4. Particulate matter filter - 2- μ m sintered stainless steel in-line filter (Nupro Co., Model SS-2F-K4-2, or equivalent).
5. Chromatographic grade stainless steel tubing and fittings - for interconnections (Alltech Associates, Cat. #8125, or equivalent). All materials in contact with sample, analyte, and support gases should be chromatographic grade stainless steel.

6.0 REAGENTS



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This section is not applicable to this SOP.

7.0 PROCEDURE

7.1 Subatmospheric Pressure Sampling

7.1.1 Sampling Using a Fixed Orifice, Capillary, or Adjustable Micrometering Valve

1. Prior to sample collection, the appropriate information is completed on the Canister Sampling Field Data Sheet (Appendix C).
2. A canister, which is evacuated to 0.05 mm Hg and fitted with a flow restricting device, is opened to the atmosphere containing the VOCs to be sampled.
3. The pressure differential causes the sample to flow into the canister.
4. This technique may be used to collect grab samples (duration of 10 to 30 seconds) or time-integrated samples (duration of 12 to 24 hours). The sampling duration depends on the degree to which the flow is restricted.
5. A critical orifice flow restrictor will have a decrease in the flow rate as the pressure approaches atmospheric.
6. Upon sample completion at the location, the appropriate information is recorded on the Canister Sampling Field Data Sheet.

7.1.2 Sampling Using a Mass Flow Controller/Vacuum Pump Arrangement (Andersen Sampler Model 87-100)

1. Prior to sample collection the appropriate information is completed on the Canister Sampling Field Data Sheet (Appendix C).
2. A canister, which is evacuated to 0.05 mm Hg and connected in line with the sampler, is opened to the atmosphere containing the VOCs to be sampled.
3. A whole air sample is drawn into the system through a stainless steel inlet tube by a direct drive blower motor assembly.
4. A small portion of this whole air sample is pulled from the inlet tube by a specially modified inert vacuum pump in conjunction with a mass flow controller.
5. The initially evacuated canister is filled by action of the flow controlled pump to near atmospheric pressure.
6. A digital time-program is used to pre-select sample duration and start and stop



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times.

7. Upon sample completion at the location, the appropriate information is recorded on the Canister Sampling Field Data Sheet.

7.2 Pressurized Sampling

7.2.1 Sampling Using a Mass Flow Controller/Vacuum Pump Arrangement (Andersen Sampler Model 87-100)

1. Prior to sample commencement at the location, the appropriate information is completed on the Canister Sampling Field Data Sheet.
2. A canister, which is evacuated to 0.05 mm Hg and connected in line with the sampler, is opened to the atmosphere containing the VOCs to be sampled.
3. A whole air sample is drawn into the system through a stainless steel inlet tube by a direct drive blower motor assembly.
4. A small portion of this whole air sample is pulled from the inlet tube by a specially modified inert vacuum pump in conjunction with a mass flow controller.
5. The initially evacuated canister is filled by action of the flow controlled pump to a positive pressure not to exceed 25 psig.
6. A digital time-programmer is used to pre-select sample duration and start and stop times.
7. Upon sample completion at the location, the appropriate information is recorded on the Canister Sampling Field Data Sheet.

8.0 CALCULATIONS

1. A flow control device is chosen to maintain a constant flow into the canister over the desired sample period. This flow rate is determined so the canister is filled to about 88.1 kPa for subatmospheric pressure sampling or to about one atmosphere above ambient pressure for pressurized sampling over the desired sample period. The flow rate can be calculated by:

$$F = \frac{(P)(V)}{(T)(60)}$$

where:

F = flow rate (cm³/min)
P = final canister pressure, atmospheres absolute
V = volume of the canister (cm³)



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T = sample period (hours)

For example, if a 6-L canister is to be filled to 202 kPa (two atmospheres) absolute pressure in 24 hours, the flow rate can be calculated by:

$$F = \frac{(2)(6000)}{(24)(60)} = .3 \text{ cm}^3/\text{min}.$$

2. If the canister pressure is increased, a dilution factor (DF) is calculated and recorded on the sampling data sheet.

$$DF = \frac{Y_a}{X_a}$$

where:

X_a = canister pressure (kPa, psia) absolute before dilution.

Y_a = canister pressure (kPa, psia) absolute after dilution.

After sample analysis, detected VOC concentrations are multiplied by the dilution factor to determine concentration in the sampled air.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on standard chain of custody records, field data sheets, or site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety practices. Specifically, pressurizing of Summa canisters should be performed in a well ventilated room, or preferably under a fume hood. Care must be taken not to exceed 40 psi in the canisters. Canisters are under pressure, albeit only 20-30 psi, and should not be dented or punctured. They should be stored in a cool dry place and always be placed in their plastic shipping boxes during transport and storage.

12.0 REFERENCES



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APPENDIX A
Volatile Organic Compound Data Sheet
SOP #1704
July 1995



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SUMMA CANISTER SAMPLING

Volatile Organic Compound Data Sheet

TABLE 1. VOLATILE ORGANIC COMPOUND DATA SHEET

COMPOUND (SYNONYM)	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°C)	MELTING POINT (°C)	CAS NUMBER
Freon 12 (Dichlorodifluoromethane)	Cl ₂ CF ₂	120.91	-29.8	-158.0	74-87-3
Methyl chloride (Chloromethane)	CH ₃ Cl	50.49	-24.2	-97.1	
Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	ClCF ₂ CClF ₂	170.93	4.1	-94.0	
Vinyl chloride (Chloroethylene)	CH ₂ =CHCl	62.50	-13.4	-1538.0	75-01-4
Methyl bromide (Bromomethane)	CH ₃ Br	94.94	3.6	-93.6	74-83-9
Ethyl chloride (Chloroethane)	CH ₃ CH ₂ Cl	64.52	12.3	-136.4	75-00-3
Freon 11 (Trichlorofluoromethane)	CCl ₃ F	137.38	23.7	-111.0	75-35-4
Vinylidene chloride (1,1-Dichloroethene)	C ₂ H ₂ Cl ₂	96.95	31.7	-122.5	
Dichloromethane (Methylene chloride)	CH ₂ Cl ₂	84.94	39.8	-95.1	75-09-2
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	CF ₂ ClCCl ₂ F	187.38	47.7	-36.4	74-34-3
1,1-Dichloroethane (Ethylidene chloride)	CH ₃ CHCl ₂	98.96	57.3	-97.0	
cis-1,2-Dichloroethylene	CHCl=CHCl	96.94	60.3	-80.5	
Chloroform (Trichloromethane)	CHCl ₃	119.38	61.7	-63.5	67-66-3
1,2-Dichloroethane (Ethylene dichloride)	ClCH ₂ CH ₂ Cl	98.96	83.5	-35.3	107-06-2
Methyl chloroform (1,1,1-Trichloroethane)	CH ₃ CCl ₃	133.41	74.1	-30.4	71-55-6
Benzene (Cyclohexatriene)	C ₆ H ₆	78.12	80.1	5.5	71-43-2
Carbon tetrachloride (tetrachloromethane)	CCl ₄	153.82	76.5	-23.0	56-23-5
1,2-Dichloropropane (Propylene dichloride)	CH ₃ CHClCH ₂ Cl	112.99	96.4	-100.4	78-87-5
Trichloroethylene (Trichloroethene)	ClCH=CCl ₂	131.29	87	-73.0	79-01-6
cis-1,3-Dichloropropene (cis-1,3-dichloropropylene)	CH ₃ CCl=CHCl	110.97	76		
trans-1,3-Dichloropropene (cis-1,3-Dichloropropylene)	ClCH ₂ CH=CHCl	110.97	112.0		
1,1,2-Trichloroethane (Vinyl trichloride)	CH ₂ ClCHCl ₂	133.41	113.8	-36.5	79-00-5
Toluene (Methyl benzene)	C ₆ H ₅ CH ₃	92.15	110.6	-95.0	108-88-3
1,2-Dibromoethane (Ethylene dibromide)	BrCH ₂ CH ₂ Br	187.88	131.3	9.8	106-93-4
Tetrachloroethylene (Perchloroethylene)	Cl ₂ C=CCl ₂	165.83	121.1	-19.0	127-18-4
Chlorobenzene (Phenyl chloride)	C ₆ H ₅ Cl	112.56	132.0	-45.6	108-90-7
Ethylbenzene	C ₆ H ₅ C ₂ H ₅	106.17	136.2	-95.0	100-41-4
m-Xylene (1,3-Dimethylbenzene)	1,3-(CH ₃) ₂ C ₆ H ₄	106.17	139.1	-47.9	100-42-5
p-Xylene (1,4-Dimethylxylene)	1,4-(CH ₃) ₂ C ₆ H ₄	106.17	138.3	13.3	
Styrene (Vinyl benzene)	C ₆ H ₅ CH=CH ₂	104.16	145.2	-30.6	
1,1,2,2-Tetrachloroethane	CHCl ₂ CHCl ₂	167.85	146.2	-36.0	79-34-5
o-Xylene (1,2-Dimethylbenzene)	1,2-(CH ₃) ₂ C ₆ H ₄	106.17	144.4	-25.2	108-67-8
1,3,5-Trimethylbenzene (Mesitylene)	1,3,5-(CH ₃) ₃ C ₆ H ₃	120.20	164.7	-44.7	
1,2,4-Trimethylbenzene (Pseudocumene)	1,2,4-(CH ₃) ₃ C ₆ H ₃	120.20	169.3	-43.8	95-63-6
m-Dichlorobenzene (1,3-Dichlorobenzene)	1,3-Cl ₂ C ₆ H ₄	147.01	173.0	-24.7	541-73-1
Benzyl chloride (α-Chlorotoluene)	C ₆ H ₅ CH ₂ Cl	126.59	179.3	-39.0	100-44-7
o-Dichlorobenzene (1,2-Dichlorobenzene)	1,2-Cl ₂ C ₆ H ₄	147.01	180.5	-17.0	95-50-1
p-Dichlorobenzene (1,4-Dichlorobenzene)	1,4-Cl ₂ C ₆ H ₄	147.01	174.0	53.1	106-46-7
1,2,4-Trichlorobenzene	1,2,4-Cl ₃ C ₆ H ₃	181.45	213.5	17.0	120-82-1
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)					



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SUMMA CANISTER SAMPLING

APPENDIX B

Figure
SOP #1704
July 1995

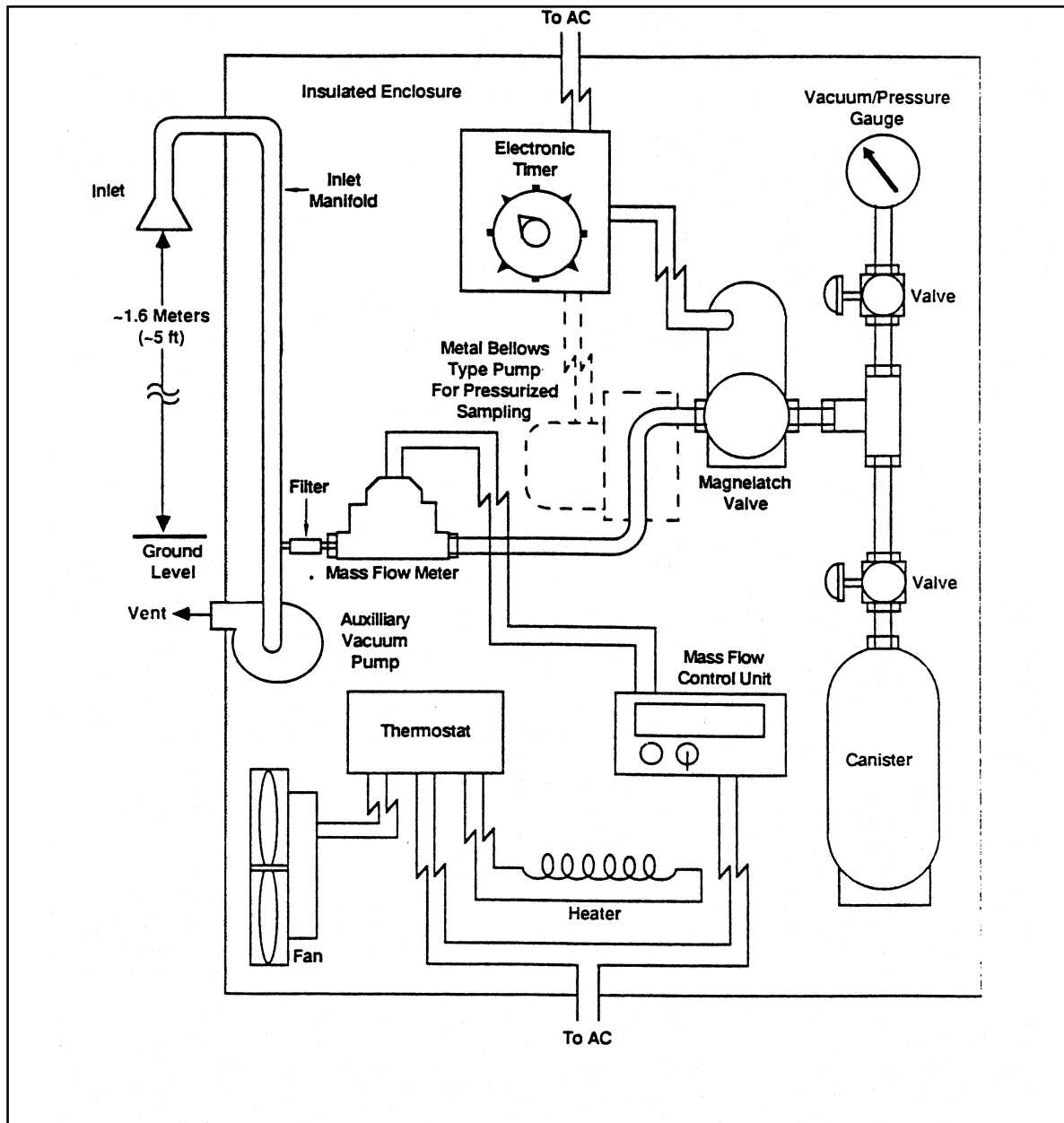


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FIGURE 1. Subatmospheric/Pressurized Sampling Equipment





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APPENDIX C

Canister Sampling Field Data Sheet
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SUMMA CANISTER SAMPLING



EPA/Environmental Response Team
Scientific, Engineering, Response and Analytical Services
Lockheed Martin Corp., Edison, NJ
U.S. EPA Contract No. EP-W-09-031

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Air Sampling Work Sheet

Site: _____

WA# _____

Sampler: _____

U.S. EPA/ERT WAM: _____

Date: _____

REAC Task Leader: _____

Sample #					
Location					
Summa #					
Orifice ID					
Analysis/Method					
Start Pressure					
End Pressure					
Time/Counter (Start)					
Time/Counter (Stop)					
Total Time					
Flow Rate (Start)					
Flow Rate (End)					
Flow Rate Average					
Sample Volume					

MET Station on Site?: Y / N

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 002

REVISION NO. 4

Last Reviewed: March 2018



Quality Assurance Approved

March 9, 2018

Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. All sampling equipment must be thoroughly cleaned before each use to prevent contamination of samples.

1.3 DEFINITIONS

Alconox: Phosphate-containing soap, obtained in powder form and dissolved in water

Liquinox: Phosphate-free soap, obtained in liquid form for mixing with water

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992a. “Guide to Management of Investigation-Derived Wastes.” Office of Solid Waste and Emergency Response. Washington, DC. EPA 9345.3-03FS. January.

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1.5 REQUIREMENTS AND RESOURCES

The equipment and supplies to conduct decontamination may include the following:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles
- Alconox or Liquinox (Note: Alconox contains phosphates, and phosphates have been banned in many household cleaning products based on their adverse effect on the environment.)
- Tap water
- Distilled water
- Deionized water
- Plastic sheeting
- Aluminum foil
- Isopropanol (laboratory grade)

2.0 PROCEDURE

The procedures below discuss decontamination of personal protective equipment (PPE) as well as equipment for drilling and monitoring well installation, borehole soil sampling, general sampling, water level measurement, and groundwater sampling. PPE as outlined in the site-specific health and safety plan should be used during decontamination procedures. Special handling of used PPE and wastewater generated from decontamination procedures may be required if the type of contamination is considered hazardous according to the Resource Conservation and Recovery Act (RCRA). Any special handling should also be outlined in the site-specific health and safety plan or the sampling and analysis plan.

Some clients may have additional requirements for decontamination procedures. For example, phosphate-free detergent may be a requirement and, therefore, it would not be appropriate to use Alconox.

Source water for decontamination should be selected based on site-specific conditions and contaminants. Organic-free water would be more appropriate to use at sites where organic compounds are being investigated; conversely, laboratory-grade deionized water would be more appropriate where low levels of contaminants are being investigated. Standard distilled water, readily available at grocery stores, may be appropriate at other times. Refer to the site-specific sampling and analysis plan for details concerning source water.

In general, conduct field activities to move from cleaner to more contaminated locations to minimize the potential for cross contamination between locations.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off site or to clean areas. Refer to the site-specific health and safety plan as the first resource for types of PPE; not all types of PPE nor methods for decontamination discussed below will be appropriate for every site. All used disposable protective clothing, such as Tyvek, coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums (refer to Section 3.0).

Personnel decontamination procedures will be as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.
3. Remove outer gloves and place into plastic bag for disposal.
4. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for reuse.
5. Remove air purifying respirator (APR), if used, and place the spent filters in a plastic bag for disposal. Filters should be changed daily or sooner, depending on use and application. Place the respirator into a separate plastic bag after it has been cleaned and disinfected according to the instructions for the respirator.
6. Remove disposable gloves and place them in plastic bag for disposal.
7. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated at a designated location on site before drilling operations begin, between borings, and at completion of the project. Decontamination may be conducted on a temporary decontamination pad constructed at a satellite location within the site. The purpose of the decontamination pad is to contain wash waters and potentially contaminated soil generated during decontamination procedures. Decontamination pads may be constructed of concrete, wood, or plastic sheeting, depending on the site-specific needs and plans. Wash waters and contaminated soil generated during decontamination should be considered investigation-derived waste (IDW) and, thus, should be collected and containerized for proper disposal.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they may be steam cleaned and placed on polyethylene sheeting on site before they are used downhole, if required by the site-specific work plan. The drilling subcontractor will typically furnish the steam cleaner and water.

The drilling auger, bits, drill pipe, any portion of drill rig that is over the borehole, temporary casing, surface casing, and other equipment used in or near the borehole should be decontaminated by the drilling subcontractor as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Remove loose soil using shovels, scrapers, wire brushes, and any related material.
3. Steam clean or pressure wash to remove all visible dirt. Use appropriate PPE (for example, a face shield and Tyvek/coveralls) as necessary.
4. If equipment has directly or indirectly contacted contaminated media and is known or suspected of being contaminated with oil, grease, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), or other hard-to-remove organic materials, rinse equipment with laboratory-grade isopropanol.
5. To the extent possible, allow components to air dry; drying helps limit the spread of contamination through contact.
6. All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING DOWNHOLE EQUIPMENT DECONTAMINATION AND GENERAL SOIL SAMPLING EQUIPMENT DECONTAMINATION

All soil sampling equipment should be decontaminated before use and after each sample as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Scrub the split-barrel sampler and sampling tools in a wash bucket or tub using a stiff, long-bristle brush with a solution of tap water with Liquinox or Alconox.
3. Rinse equipment thoroughly with tap water or distilled water.
4. Perform a final rinse with deionized or distilled water. Refer to the site-specific sampling and analysis plan for requirements for deionized or distilled water.
5. Place cleaned equipment in a clean area on plastic sheeting or aluminum foil and allow to air-dry.
6. Containerize all water and rinsate; disposable single-use sampling equipment should also be containerized.

2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Wipe the tape and probe with a disposable Alconox- or Liquinox-impregnated cloth or paper towel.
3. If immiscible layers are encountered, the interface probe may require steam cleaning or washing with laboratory-grade isopropanol.
4. Rinse with distilled or deionized water.
5. Containerize all water and rinsate for proper disposal.

2.5 GROUNDWATER SAMPLING EQUIPMENT

The following procedures are to be employed to decontaminate equipment used for groundwater sampling. Decontamination is not necessary when using disposable (single-use) pump tubing or bailers. Bailer and downhole pumps decontamination procedures are described in the following sections.

2.5.1 Bailers

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Remove and containerize any purge water remaining in the bailer.
3. Scrub the inside and outside of the bailer in a wash bucket or tub using a stiff, long-bristle brush with a solution of tap water with Liquinox or Alconox. Select cleaning equipment that will not scratch or damage the bailer.
4. Rinse the bailer thoroughly with tap water or distilled water.
5. If groundwater contains or is suspected to contain oil, grease, PAHs, PCBs, or other hard-to-remove organic materials, rinse equipment with laboratory-grade isopropanol.
6. Perform a final rinse with deionized or distilled water.
7. Allow the cleaned bailer to air dry.
8. Wrap the bailer in aluminum foil or a clean plastic bag for storage.
9. Containerize the decontamination wash waters for proper disposal.

2.5.2 Downhole Pumps

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Remove and containerize any purge water in the pump and tubing and dispose of tubing.
3. Dismantle the pump as much as possible and scrub components in a wash bucket or tub using a stiff brushes of appropriate size with a solution of tap water with Liquinox or Alconox.
4. Rinse pump components thoroughly with tap water or distilled water.

5. If groundwater contains or is suspected to contain oil, grease, PAHs, PCBs, or other hard-to-remove organic materials, rinse the pump and tubing with laboratory-grade isopropanol.
6. Perform a final rinse with deionized or distilled water.
7. Allow components to air dry.
8. Wrap pump in aluminum foil or a clean plastic bag for storage.
9. Containerize the used tubing and decontamination wash waters for proper disposal.

3.0 INVESTIGATION-DERIVED WASTE

IDW can include disposable single-use PPE and sampling equipment, soil cuttings, and decontamination wash waters and sediments. Requirements for waste storage may differ from one facility to the next. Facility-specific directions for waste storage will be provided in project-specific documents, or separate direction will be provided by the project manager. The following guidelines are provided for general use:

1. Assume that all IDW generated from decontamination contains the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. Waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.
2. Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility.
3. Label IDW storage containers with the facility name and address, date, contents, company generating the waste, and an emergency contact name and phone number.
4. Temporarily store the IDW in a protected area that provides access to the containers and allows for spill/leak monitoring, sampling of containers, and removal after the disposal method has been identified.

SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

PACKAGING AND SHIPPING SAMPLES

SOP NO. 019

REVISION NO. 8

Last Reviewed: August 2020



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Date

1.0 BACKGROUND

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. This standard operating procedure (SOP) describes procedures for packaging and shipping samples. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples.

1.1 PURPOSE

This SOP establishes the requirements and procedures for packaging and shipping nonhazardous environmental samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) “Contract Laboratory Program Guidance for Field Samplers.” Procedures described in this SOP should be followed for all routine sample packaging and shipping of nonhazardous samples. If procedures are to be modified for particular contract- or laboratory-specific requirements, modified procedures should be clearly described in site-specific plans such as work plans, field sampling plans (FSP), or quality assurance project plans (QAPP). Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already in the appropriate sample jars and that the sample jars are labeled.

This SOP does not cover the packaging and shipment of Dangerous Goods or Hazardous Materials.

The shipment of Dangerous Goods (by air) and Hazardous Materials (by ground) requires specialized training. If you have NOT received this training in the last 2 years, you are NOT qualified to package or ship these materials and may be personally liable for any damages or fines. Contact one of Tetra Tech’s shipping experts for assistance. Instructions to access the training course, shipping experts, and health and safety (H&S) contacts, and general information on packaging and shipping hazardous substances and dangerous goods can be obtained by checking the links provided in [Section 1.4](#) (References) and communicating with appropriate Tetra Tech H&S contacts listed on the EMI Operating unit internal H&S web site.

1.2 SCOPE

This SOP applies to packaging and shipping of environmental and nonhazardous samples. This SOP does not address shipping dangerous goods or hazardous materials.

1.3 DEFINITIONS

Airbill: An airbill is a shipping form (such as a FedEx shipping form) acquired from the commercial shipper and is used to document shipment of the samples from the sampler to the designated analytical laboratory (see [Figure 1](#)).

Blank: A blank is any sample that is used to assess cross-contamination from sampling and sample management procedures. A typical blank sample will consist of distilled or deionized (DI) water (water sampling) or an air filter cartridge (air sampling) that is then analyzed by the laboratory to evaluate whether cross-contamination has been introduced. Each blank is assigned its own unique sample number. Blanks collected in the field include trip blanks, field blanks, and equipment blanks, all intended to assess potential cross-contamination. For example, a trip blank checks for contamination during sample handling, storage, and shipment from the field to the laboratory. Field blanks assess the contamination of water or soil from ambient air. Equipment blanks (also known as rinse blanks) assess contamination from incomplete decontamination procedures.

Chain-of-Custody form: A chain-of-custody form is used to document the transfer of custody of samples from the field to the designated analytical laboratory (see [Figure 2](#)). The chain-of-custody form is critical to the chain-of-custody process and is used to identify the samples in each shipping container to be shipped or delivered to the laboratory for chemical or physical (geotechnical) analysis. A copy of the chain-of-custody form is shipped with the samples and accompanies them from sampler to laboratory (see [Figure 3](#)).

Custody seal: A custody seal is a tape-like seal and is used to indicate that samples are intact and have not been disturbed during shipping or transport after the samples have been released from the sampler to the shipper (see [Figure 4](#)). The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping (see [Figure 5](#)).

Environmental samples: Environmental samples include drinking water, groundwater, surface water, soil, sediment, treated municipal and industrial wastewater effluent, indoor and ambient air, nonhazardous bulk materials, soil gas, dust, asbestos, and biological specimens. Environmental samples typically contain low concentrations of contaminants and, when handled, require only limited precautionary procedures.

Nonhazardous samples: Nonhazardous samples are those samples that do not meet the definition of a hazardous sample AND do not need to be packaged and shipped in accordance with the International Air Travel Association's (IATA) "Dangerous Goods Regulations" (DGR) or U.S. Department of Transportation's "Hazardous Materials Regulations" defined in Title 49 *Code of Federal Regulations* (CFR).

The following definitions are provided to further distinguish environmental and nonhazardous samples from dangerous goods and hazardous samples:

Dangerous goods: Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 2020).

Hazardous samples: Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the Hazardous Material Regulations.

Hazardous substance: A hazardous substance is any material, including its mixtures and solutions, that is listed in 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity listed in Table 1 to Appendix A of 49 CFR 172.101.

1.4 REFERENCES

General Awareness, H&S Contacts, and Course Training Information (Tetra Tech, Inc., EMI Operating Unit. Intranet) On-line address: <https://int.tetrattech.com/sites/EMI/hs/Pages/Dangerous-Goods-Shipping.aspx>

International Air Transport Association (IATA). 2020. "Dangerous Goods Regulations. 2020." For sale at: <https://www.iata.org/en/publications/dgr/>. Updated annually, with new edition available late in year.

U.S. Environmental Protection Agency (EPA). 40 CFR, 763 Subpart F, Asbestos Hazards Emergency Response Act (AHERA).

EPA. 2014. "Contract Laboratory Program Guidance for Field Samplers." EPA 540-R-014-013. October. On-line address: https://www.epa.gov/sites/production/files/2015-03/documents/samplers_guide.pdf.

EPA. 2020. "Packing, Marking, Labeling and Shipping of Environmental and Waste Samples." EPA Region 4, LSASDPROC-209-R4. February 23. On-line address: <https://www.epa.gov/sites/production/files/2015-06/documents/Shipping-Environmental-and-Waste-Samples.pdf>

1.5 REQUIREMENTS AND RESOURCES

The procedures for packaging and shipping samples require the following:

- Coolers (insulated ice chest) or other shipping containers appropriate to sample type
- Ice
- Bubble wrap or similar cushioning material
- Chain-of-custody forms and seals
- Airbills

- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)
- Large plastic garbage bags for lining the cooler
- Temperature blank sample bottle filled with distilled water can be included in the cooler if appropriate to sample type
- Trip blank samples used to check for volatile contamination during sample handling in the field should accompany sample containers during shipment from laboratory to field (empty containers) and from field to laboratory (filled containers). It should remain in the cooler with sample containers during the sampling event. Trip blanks should be requested from the laboratory when containers are initially ordered.

2.0 PROCEDURES

The following procedures apply to packaging and shipping nonhazardous and environmental samples.

2.1 PACKAGING SAMPLES

After they have been appropriately containerized and labeled, environmental samples should be packaged as described in this section. This section covers procedures for packing samples for delivery by commercial carrier (air or ground) and hand delivery of environmental samples (by employee or courier), as well as shipping asbestos and air quality samples. Note that these instructions are general; samplers also should be aware of client-specific requirements concerning the placement of custody seals or other packaging provisions.

2.1.1 Packaging Samples for Delivery by Commercial Carrier (Air or Ground)

Samples shipped by commercial carriers should be packed for shipment using the following procedures and in compliance with all carrier requirements:

Preparing the sample:

1. Allow a small amount of headspace in all bottles, or as instructed by the laboratory (except volatile organic compound [VOC] containers with a septum seal) to compensate for any changes in pressure and temperature during transfer.
2. Be sure the lids on all bottles are tight (will not leak). Lids maybe taped or sealed with custody seals as added protection or as required. For any sample containers that are not marked with a tare weight by the laboratory, cover the completed sample label on the container with clear tape to protect the label.
3. Place sample containers in resealable plastic bags.

Preparing the cooler:

1. Secure and tape the drain plug of the cooler with fiber or duct tape.
2. Line the cooler with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.
3. Wrap the sample containers in bubble wrap or line the cooler (bottom and sides) with a cushioning material to prevent breakage of bottles or jars during shipment.
4. If required by the laboratory for the analytical method, add a sufficient quantity of ice to the cooler to cool samples to 4 °C (± 2 °C). Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. If required, include one temperature blank (a sample bottle filled with distilled water) per cooler.

5. For VOC samples only, include one trip blank for VOC analysis per shipment matrix in each cooler.
6. Fill all remaining space between the bottles or jars with bubble wrap.
7. As each container is placed in the cooler, verify the sample information on the chain-of-custody form. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler.
8. Securely fasten the top of the large garbage bag with tape (preferably plastic electrical tape).
9. If more than one cooler is being shipped, mark each cooler as “1 of 2,” “2 of 2,” and so forth.
10. Place the chain-of-custody forms (see [Figure 2](#)) into a resealable plastic bag, and tape the bag to the inner side of the cooler lid (see [Figure 3](#)). If you are shipping more than one cooler, copy the chain-of-custody form so that there is one copy of all forms in each cooler. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler. Tape any instructions for returning the cooler to the inside of the lid.
11. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once.
12. Place two signed custody seals (see [Figure 4](#)) on opposite sides of the cooler, ensuring that each one covers the cooler lid and side of the cooler (see [Figure 5](#); note that in contrast to the figure, the seals should be placed on the opposite sides of the cooler and offset from each other, rather than directly across from each other as shown in [Figure 5](#)). Place clear plastic tape over the custody seals so that the cooler cannot be opened without breaking the seal.
13. Shipping containers should be marked “THIS END UP.” Arrow labels, which indicate the proper upward position of the container, may also be affixed to the container. As appropriate, the containers should also be labeled for Saturday delivery or other special requirements.
14. Ship samples overnight using a commercial carrier such as FedEx. As a best practice, electronic sample shipping labels should be prepared by the shipping agency’s employees, at the direction of Tetra Tech employees or sampling personnel. This allows the sampling personnel to confirm special shipping requirements, such as Saturday delivery, and verify that samples will be shipped that day (that is, the last shipment of the day has not already occurred). If this is not possible, the airbill can be prepared by hand (see [Figure 1](#)), but samples should still be handed over directly to shipping agency employees and shipping details should be verified. The shipping label should be placed on the outside of the container.
15. A copy of the receipt with sample tracking number should be retained by the sampling personnel and delivery should be verified the next day.

2.1.2 Hand Delivery of Environmental Samples (by Employee or Courier)

Samples hand-delivered to the laboratory should be packed for shipment using the following procedures:

Preparing the sample:

1. Bottles can be filled completely with sample (required for VOC containers with a septum seal).

2. Be sure the lids on all bottles are tight (will not leak).

Preparing the cooler:

1. Secure and tape the drain plug of the cooler with fiber or duct tape.
2. Wrap the sample containers in bubble wrap or line the cooler (bottom and sides) with a cushioning material to prevent breakage of bottles or jars during shipment.
3. As each container is placed in the cooler, verify the sample information on the chain-of-custody form. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler.
4. If required for by the laboratory for the analytical method, add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. If required, include one temperature blank (a sample bottle filled with distilled water) per cooler.
5. For VOC samples only, include one trip blank for VOC analysis per shipment matrix in each cooler.
6. If more than one cooler is being shipped, mark each cooler as “1 of 2,” “2 of 2,” and so forth.
7. Place the chain-of-custody form (see [Figure 2](#)) in a resealable plastic bag and tape to the inside of the cooler lid (see [Figure 3](#)), close the lid, and seal with custody seals (see [Figure 5](#); note that in contrast to the figure, the seals should be placed on the opposite sides of the cooler and offset from each other, rather than directly across from each other as shown in [Figure 5](#)). Place clear plastic tape over the custody seals so that the cooler cannot be opened without breaking the seal. Transfer the cooler to the courier. When samples will be delivered directly to the laboratory, it is sufficient to close the cooler and hand-deliver it with the chain-of-custody form.
8. Include any instructions for returning the cooler to the inside of the lid.
9. If the cooler is being transferred to a courier, the shipping containers should be marked “THIS END UP,” and arrow labels, which indicate the proper upward position of the container should be affixed to the container.

2.1.3 Shipping Asbestos Samples

Asbestos samples shipped by commercial carriers should be packed for shipment using the following procedures and in compliance with all carrier requirements:

1. Place each asbestos sample in a small resealable plastic bag or Whirl-pak sealable bag. Seal the bags carefully and place the sample bags in a larger resealable plastic bag.
2. Select a rigid shipping container and pack the samples upright in a noncontaminating, nonfibrous medium such as a bubble pack to minimize excessive movement during shipping.
3. Avoid using expanded polystyrene because of its static charge potential. Also avoid using particle-based packaging materials because of possible contamination.

4. Affix custody seals to the samples or outer sample bag so that the bags cannot be opened without breaking the seal.
5. Insert the chain-of-custody form in the box. Include a shipping bill and a detailed listing of samples shipped, their descriptions and all identifying numbers or marks, sampling data, shipper's name, and contact information.
6. Ship bulk samples in a separate container from air samples. Bulk samples and air samples delivered to the analytical laboratory in the same container will be rejected.
7. For each sample set, designate which are the ambient samples, which are the abatement area samples, which are the field blanks, and which is the sealed blank if sequential analysis is to be performed.
8. Hand-carry samples to the laboratory in an upright position if possible; otherwise, choose that mode of transportation least likely to shake the samples in transit.
9. Address the package to the laboratory sample coordinator by name when known and alert him or her of the package description, shipment mode, and anticipated arrival as part of the chain-of-custody and sample tracking procedures. This information will also help the laboratory schedule timely analysis for the samples when they are received.

2.1.4 Shipping Air Samples

Packaging and shipping requirements for air samples vary depending on the media used to collect the samples and the analyses required. Sampling media typically include Summa canisters and Tedlar bags for whole air samples, filters for metals and particulate matter, and sorbent tubes for organic contaminants. This section of the SOP provides general guidelines for packaging and shipping air samples collected using these media. The project FSP or QAPP should also be reviewed for any additional project-specific requirements or instructions.

Summa Canister Samples

1. Close the canister valve by tightening the knob clockwise or flipping the toggle switch. Replace the brass cap on the canister inlet.
2. If a flow controller was used to collect the air sample over a specified time interval, the flow controller should be removed before replacing the brass cap.
3. Fill out the sample tag on the canister with the sample number and the date and time of collection. Include the identification number of the flow controller on the sample tag if one was used. Make sure the information on the sample tag matches the chain-of-custody form.
4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final Summa canister vacuum readings; Summa canister identification number; and flow controller identification number.

5. Package the Summa canister (and flow controller) in its original shipping box with the original packaging material. Tape the box shut and apply custody seals if required. Note: Summa canisters should never be packaged with ice.
6. Summa canister shipments typically include several canisters, and may include more than one shipping box. The chain-of-custody form for the shipment should be sealed within one of the shipping boxes. If more than one box is being shipped, mark each box as “1 of 2,” “2 of 2,” and so forth.
7. Ship the samples by a method that will meet the holding time. Summa canister samples should be analyzed within 30 days of sample collection.

Tedlar Bag Samples

1. Before removing it from the sample port, close the Tedlar bag by tightening the valve clockwise. The bag should only be approximately half-full to allow for pressure changes during shipping and handling of the sample. Keep the Tedlar bag out of direct sunlight to preserve the sample.
2. Fill out the label on the bag with the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. Complete the chain-of-custody form.
4. Package the Tedlar bag in a shipping box with appropriate packing material to prevent the bag from being punctured or damaged. Multiple bags can be packaged in the same box. Tape the box shut and apply custody seals if required. Note: Tedlar bag samples should not be cooled or packaged with ice, although they can be shipped in an ice chest to protect the samples.
5. Tedlar bag shipments may include more than one shipping box. The chain-of-custody form for the shipment should be sealed within one of the shipping boxes. If more than one box is being shipped, mark each box as “1 of 2,” “2 of 2,” and so forth.
6. Ship the samples using priority overnight delivery. Tedlar bag samples should be analyzed within 3 days of sample collection.

Filter Cassette Samples

1. Disconnect the filter cassette from the air sampling pump and replace the plastic caps on the inlet and outlet openings.
2. Attach a label to the sample that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.
4. Package the filter cassettes in a shipping box (such as a FedEx box). Use an appropriate packing material (such as bubble wrap) to separate the samples and prevent damage.
5. Place the chain-of-custody form within the box, seal the box, and apply custody seals if required. Filter cassette samples typically do not need to be cooled, but check the field sampling plan (FSP) or Quality Assurance Project Plan (QAPP) for project-specific requirements.

6. Ship the samples by a method that will meet the holding time.

Sorbent Tube Samples

1. Disconnect the sample tube from the air sampling pump and seal both ends of the tube with plastic caps.
2. Complete a sample label that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. If the tube is small and the label cannot be attached to the tube, the tube can be placed in a small resealable plastic bag and the label can be attached to the bag or placed inside the bag with the tube.
4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.
5. Packaging requirements for the sample tubes will depend on the analysis required, and the sampler should check the FSP or QAPP for project-specific requirements (for example, tubes may need to be wrapped in aluminum foil to prevent exposure to light). Packaging containers and methods include (1) shipping boxes (as described under filter cassette samples), (2) small sample coolers filled with double-bagged ice, and (3) small sample coolers filled with blue (reusable) ice.
6. Place the chain-of-custody form within the box or container, seal the box or container, and apply a custody seal if required.
7. If coolers are used for shipping, tape instructions for returning the cooler to the inside of the lid.
8. Ship the samples by a method that will meet the holding time.

Polyurethane Foam (PUF) Tube Samples

1. Disconnect the PUF tube from the air sampling pump and wrap the tube in aluminum foil.
2. Attach a label to the wrapped sample tube that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. Wrap the PUF tube in bubble wrap and place the tube in a glass shipping jar.
4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.
5. Package the PUF tube jars in a cooler that is filled with double-bagged ice. Use bubble wrap or other cushioning material to separate the samples and prevent breakage.
6. Place the chain-of-custody form within the cooler, seal the cooler, and apply a custody seal if required.
7. If coolers are used for shipping, tape instructions for returning the cooler to the inside of the lid.
8. Ship the samples by a method that will meet the holding time. Samples collected in PUF tubes typically must be extracted within 7 days of collection.

2.2 SHIPPING DOCUMENTATION FOR SAMPLES

Airbills, chain-of-custody forms, and custody seals must be completed for each shipment of nonhazardous environmental samples.

Field staff collecting samples should also review their field work plans to confirm what documentation must be completed during each sampling event, including client-specific requirements. For example, some EPA programs have a specific requirement to use Scribe software, an environmental data management system, to create sample documentation, electronically input information into Traffic Report or chain-of-custody forms, and enter other data.

- The Scribe software can be accessed from the EPA Environmental Response Team (ERT) at the following address: http://www.ertsupport.org/scribe_home.htm
- The ERT User Manual for Scribe, reference, and training materials can be accessed from the Scribe Support Web site at the following address: <http://www.epaossc.org/scribe>

Note that some laboratories must routinely return sample shipping coolers within 14 calendar days after the shipment has been received. Therefore, the sampler should also include instructions for returning the cooler with each shipment, when possible. The sampler (not the laboratory) is responsible for paying for return of the cooler and should include shipping airbills bearing the sampler's shipping account number, as well as a return address to allow for return of the cooler. Samplers should use the least expensive option possible for returning coolers.

2.3 SHIPMENT DELIVERY AND NOTIFICATION

A member of the field sampling team must contact the laboratory to confirm it accepts deliveries on any given day, especially Saturdays. In addition, samplers should ensure the laboratory has been notified in advance of the pending shipment and notify any additional parties as required. The sampler needs to know the laboratory's contact name, address, and telephone number and be aware of the laboratory's requirements for receiving samples.

In addition, samplers should be aware of the sample holding times, shipping company's hours of operation, shipping schedule, and pick-up and drop-off requirements to avoid delays in analytical testing.

Priority Overnight Delivery

Priority overnight delivery is typically the best method for shipment. Delays caused by longer shipment times may cause the sample temperature to rise above the acceptable range of 4° C ($\pm 2^{\circ}$ C) and technical holding time may expire, which in turn may compromise sample integrity and require recollection of

samples. If sample delivery procedures are to be modified for particular contract- or laboratory-specific requirements, the procedures should be clearly described in site-specific plans such as work plans, FSPs, or QAPPs.

Saturday Delivery

If planning to ship samples for Saturday delivery, the laboratory must be contacted in advance to confirm it will accept deliveries on Saturdays or arrange for them to be accepted. In addition, samplers should ensure the laboratory has been notified in advance of the pending shipment and notify any additional parties as required.

2.4 HEALTH AND SAFETY CONSIDERATIONS

In addition to the procedures outlined in this SOP, all field staff must be aware of and follow the health and safety practices that result from the Activity Hazard Analyses (AHA) for the project. The AHAs include critical safety procedures, required controls, and minimum personal protective equipment necessary to address potential hazards. The hazards specific to project tasks must be identified and controlled to the extent practicable and communicated to all project personnel via the approved, project-specific health and safety plan (HASP).

3.0 POTENTIAL PROBLEMS

The following potential problems may occur during sample shipment:

- Leaking package. If a package leaks (either from broken sample containers or melting ice), the carrier may open the package and return the package. Special care should be taken during sample packaging to minimize potential leaks.
- Improper labeling and marking of package. If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment. A good practice is to have labels, forms, and container markings double checked by a member of the field team.
- Bulk samples and air samples delivered to the analytical laboratory in the same container. If samples are combined in this way, they will be rejected. Always ship bulk samples in separate containers from air samples.
- Issues in packing asbestos samples. When asbestos samples are shipped, avoid using expanded polystyrene because of its static charge potential. Also avoid using particle-based packaging materials with asbestos samples because of possible contamination.
- Improper, misspelled, or missing information on the shipper's declaration. The carrier will most likely notice these errors as well and return the package to the shipper. A good practice is to have another field team member double check this information.
- Missed drop off time or wrong location. Missing the drop off time or having the wrong location identified for drop off will delay delivery to the laboratory and may cause technical holding times to expire. Establish the time requirements in advance of completing the field effort and be sure and provide some contingency time for potential delays such as traffic or checking and redoing paperwork.
- Incorrectly packaging samples for analysis at multiple laboratories. For example, inorganic samples may be shipped to one laboratory for analysis, while organic samples may need to be shipped to another laboratory. All field staff should be aware which samples are to be shipped to which laboratory when they package samples for multiple types of analysis.
- Holidays or weather-related delays. Be aware of holidays and weather forecasts that could cause delays in delivery. Delays caused by longer shipping times may cause technical holding times to expire, which in turn may compromise sample integrity or require recollection of samples.
- Not noting field variances in field logbook. Field variances should be noted in the field logbook and the project manager notified. Common field variances include:
 - Less sample volume collected than planned. Notify appropriate staff and the laboratory to ensure there is an adequate amount for analysis.
 - Sample collected into incorrect jar because of broken or missing bottle-ware. Notify appropriate laboratory staff to ensure there is no confusion regarding the analysis of the sample.

FIGURE 1

EXAMPLE OF A FEDEX US AIRBILL FOR LOW-LEVEL ENVIRONMENTAL SAMPLES

FedEx Package US Airbill
FedEx Tracking Number: 1234 5678 9010

1 From: Please print and press hard.
Date: 3/1/20
Sender's FedEx Account Number: 9 9 9 9 - 9 9 9 9 - 9
Sender's Name: Tyler Hanlon Phone: 662 | 555-1812
Company:
Address: 1234 Main Street
City: Phoenix State: AZ ZIP: 85034

2 Your Internal Billing Reference
FedEx customers will appear as follows: INTERNAL

3 To:
Recipient's Name: Liam Riley Phone: 405 | 555-8300
Company: Ridgeway Design
Address: 2020 Vision Street
City: Atlanta State: GA ZIP: 30305

4 Express Package Service
Next Business Day
☐ FedEx First Overnight
☒ FedEx Priority Overnight
☐ FedEx Standard Overnight
2 or 3 Business Days
☐ FedEx 2Day AM
☐ FedEx 2Day
☐ FedEx Express Saver

5 Packaging
☐ FedEx Envelope
☐ FedEx Pak
☐ FedEx Box
☐ FedEx Tube
☒ Other

6 Special Handling and Delivery Signature Options
☐ Saturday Delivery
☐ No Signature Required
☒ Direct Signature
☐ Indirect Signature
Does this shipment contain dangerous goods?
☒ No
☐ Yes (Please specify hazard class and label on box)

7 Payment
Bill to:
☒ Sender
☐ Recipient
☐ Third Party
Total Packages: 1
Total Weight: 1
Total Declared Value: 450

Filling Out the FedEx US Airbill

- The sender *must complete* the following fields on the pre-printed airbill:
 - Section 1: Date
 - Section 1: Sender's FedEx Account Number (available from your office administrator)
 - Section 1: Sender's Name, Company, Address, and Phone Number
 - Section 2: Internal Billing Reference (Project Number) (this field may not be present on newer airbills)
 - Section 3: Recipient's Name, Company, Address, and Phone Number
 - Section 4: Express Package or Freight Services (Priority Overnight)
 - Section 5: Packaging (usually "Other," your own packaging)
 - Section 6: Special Handling (Saturday delivery if prearranged with receiving laboratory; "No" dangerous goods contained in shipment)
 - Section 7: Payment ("Bill to Sender")
 - Section 7: Total Number of Packages
 - Section 7: Total Weight (completed by FedEx employee)
 - Section 8: Delivery Signature Options ("No Signature Required")

Completing a Sample Chain-of-Custody Form (See Also Section 2.2 on SCRIBE for Forms)

After samples have been collected, they will be maintained under chain-of-custody procedures. These procedures are used to document the transfer of custody of the samples from the field to the designated

analytical laboratory. The same chain-of-custody procedures will be used for the transfer of samples from one laboratory to another, if required.

The field sampling personnel will complete a Chain-of-Custody and Request for Analysis (CC/RA) form for each separate container of samples to be shipped or delivered to the laboratory for chemical or physical (geotechnical) analysis. These forms are often triplicate, carbonless forms. Care should be taken when completing the form that all copies are legible—PRESS FIRMLY WHEN WRITING. Information on the form will include:

1. Project identification (ID) (for example, contract and task order number);
2. Project Contract Task Order (CTO) number;
3. Laboratory Project Order (PO) number;
4. Tetra Tech Technical Contact;
5. Tetra Tech Project Manager;
6. Laboratory name;
7. Field sampler names;
8. Field sampler signature;
9. Sample ID;
10. Date and time of sampling;
11. Sample matrix type;
12. Sample preservation method; note “NONE” if no preservatives;
13. Number and types of containers per sample;
14. Sample hazards (if any);
15. Requested analysis;
16. Requested sample turnaround time or any special remarks (for example, possible presence of free product or high screening concentrations);
17. Page __ of __;
18. Method of shipment;
19. Carrier/waybill number (if any);
20. Signature, name, and company of the person relinquishing the samples and the person receiving the samples when custody is transferred;

21. Date and time of sample custody transfer;
22. Condition of samples when they are received by the laboratory.

The sample collector will cross out any blank space on the CC/RA form below the last sample number listed on the part of the form where samples are listed.


The sampling personnel whose signature appears on the CC/RA form is responsible for the custody of a sample from time the sample is collected until the custody of the sample is transferred to a designated laboratory, a courier, or to another Tetra Tech employee for transporting a sample to the designated laboratory. A sample is considered to be in custody when the custodian: (1) has direct possession of it; (2) has plain view of it; or (3) has securely locked it in a restricted access area.

Custody is transferred when both parties to the transfer complete the portion of the CC/RA form under “Relinquished by” and “Received by” or a sample is left at a FedEx facility pending shipment.

Signatures, printed names, company names, and date and time of custody transfer are required. When custody is transferred, the Tetra Tech sampling personnel who relinquished the samples will retain the third sheet (pink copy) of the CC/RA form. When the samples are shipped by a common carrier, a Bill of Lading supplied by the carrier will be used to document the sample custody, and its identification number will be entered on the CC/RA form. Receipts of Bills of Lading will be retained as part of the permanent documentation in the Tetra Tech project file.

FIGURE 2

EXAMPLE OF A CHAIN-OF-CUSTODY FORM (WHITE COPY)



Tetra Tech EM Inc.
 Oakland Office
 1999 Harrison Street, Suite 500
 Oakland, CA 94612
 510.302.6300 Phone
 510.433.0830 Fax

Chain of Custody Record No. 9814 13G175 Page 1 of 1

Lab PO#: <u>130AK 27</u>		Lab: <u>EMAX</u>		No./Container Types		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="10">Preservative Added</th> </tr> <tr> <td>NOV</td><td>NOV</td><td>NOV</td><td>NOV</td><td>NOV</td><td>NOV</td><td>NOV</td><td>NOV</td><td>NOV</td><td>NOV</td> </tr> </table>										Preservative Added										NOV	NOV	NOV	NOV	NOV	NOV	NOV	NOV	NOV	NOV
Preservative Added																																			
NOV	NOV	NOV	NOV	NOV	NOV	NOV	NOV	NOV	NOV																										
Project name: <u>Concord RA RW1</u>		TEMI technical contact: <u>Sara Woolley</u>		Field samplers: <u>Sandy Jack</u> <u>Rebecca Johnson</u>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="10">Analysis Required</th> </tr> <tr> <td>VOA</td><td>SVOA</td><td>Pest</td><td>Metals</td><td>TPH Purgeables</td><td>TPH Extractables</td><td>PCB</td><td></td><td></td><td></td> </tr> </table>										Analysis Required										VOA	SVOA	Pest	Metals	TPH Purgeables	TPH Extractables	PCB			
Analysis Required																																			
VOA	SVOA	Pest	Metals	TPH Purgeables	TPH Extractables	PCB																													
Project (CTO) number: <u>1036H59029</u>		TEMI project manager: <u>Steve DelHomme</u>		Field samplers' signatures: <u>[Signature]</u> <u>[Signature]</u>																															
Sample ID	Point ID/Depth	Date	Time	Matrix	MS / MSD	40 ml VOA	1 liter Amber	500 ml Poly	Sieve	Glass Jar	250 ml Poly	Encore	VOA	SVOA	Pest	Metals	TPH Purgeables	TPH Extractables	PCB																
1 0295RE SSØ1		7/22/13	1240	Soil						2			X	X	X	X	X	X	X																
2 0295RE SSØ2		7/22/13	1245	I						2			X	X	X	X	X	X	X																
3 0295C3 DSSØ1		7/24/13	1208								1			X	X	X	X	X	X																
4 029C3D SSØ2			1215								1			X	X	X	X	X	X																
5 029C3D SSØ3			1230								1			X	X	X	X	X	X																
6 029C3D SSØ4			1245							1			X	X	X	X	X	X	X																

Relinquished by:	Name (print)	Company Name	Date	Time
Received by: <u>[Signature]</u>	<u>Rebecca Johnson</u>	<u>Tetra Tech</u>	<u>7/20/13</u>	<u>1630</u>
Relinquished by:	<u>Rebecca Johnson</u>	<u>EMAX</u>	<u>7/30/13</u>	<u>0930</u>
Received by:				
Relinquished by:				
Received by:				

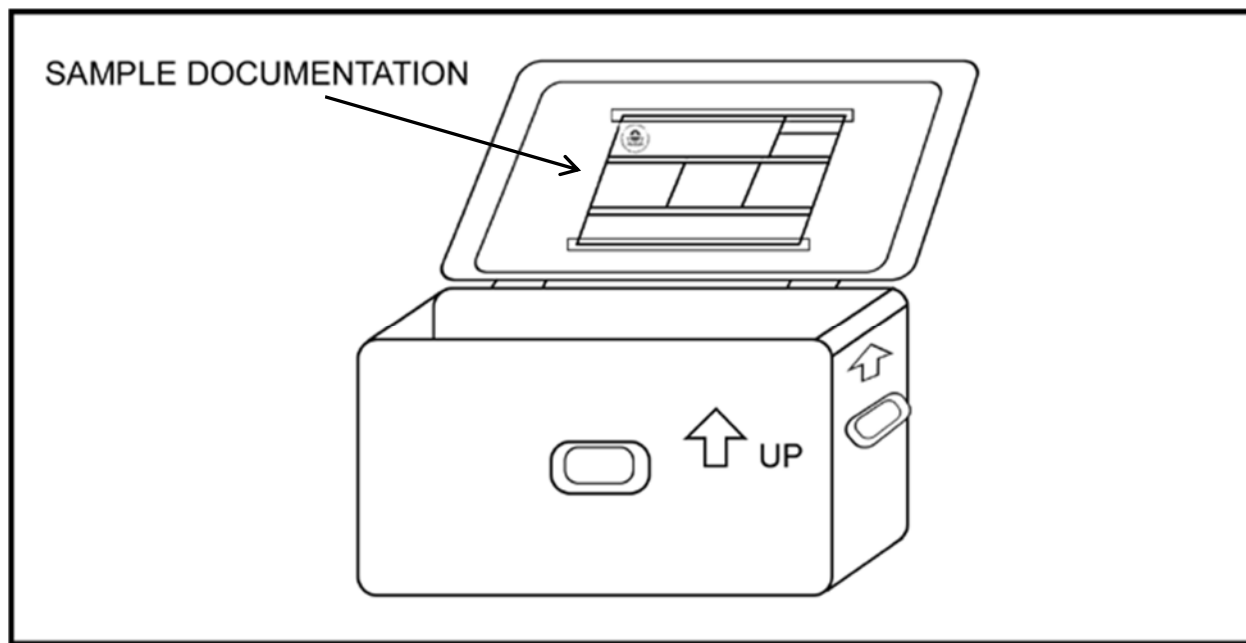
Turnaround time/remarks: Standard TAT Temp - 20°C

Priority: SVOCs, TPH-e on 029C3DSSØ1 → Ø4 then metals

Fed Ex #: 8612 4667 7215

FIGURE 3

EXAMPLE OF A SAMPLE COOLER WITH ATTACHED DOCUMENTATION



Source: U.S. Environmental Protection Agency. 2014.

Place the necessary paperwork (chain-of-custody form, cooler return instructions, and associated paperwork) in the shipping cooler or acceptable container. All paperwork must be placed in a plastic bag or pouch and then secured to the underside of the shipping container lid.

FIGURE 4

EXAMPLE OF A CUSTODY SEAL

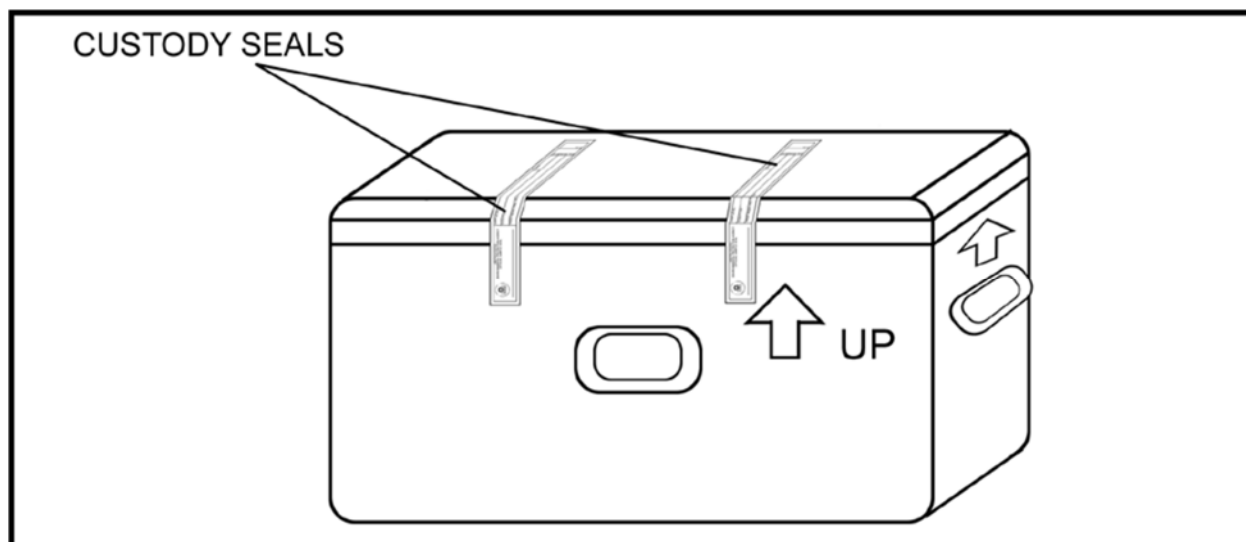
Custody Seal

DATE

SIGNATURE

FIGURE 5

EXAMPLE OF SHIPPING COOLER WITH CUSTODY SEALS



Source: U.S. Environmental Protection Agency. 2014.

Please note that the two seals typically are affixed to opposite sides of the cooler and offset from each other, although the offset is not depicted on the EPA figure above.

SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

RECORDING NOTES IN FIELD LOGBOOKS

SOP NO. 024

REVISION NO. 3

Last Reviewed: July 2020



Quality Assurance Approved

July 2, 2020

Date

1.0 BACKGROUND

Complete and accurate field documentation is critical to a successful project and the field logbook is an important tool to support field documentation needs. The field logbook should include detailed records of all field activities, document interviews with people, and record observations of conditions at a site. Entries should be described in a level of detail to allow personnel to reconstruct, after the fact, activities and events that occurred during their field assignments. Furthermore, entries should be limited to facts. Avoid speculation related to field events and do not record hearsay or unfounded information that may be presented by other parties during field activities. For example, do not record theories regarding the presence or absence of contamination when you are collecting field screening data or speculation regarding the reasons for a property owner's refusal to grant access for sampling.

Field logbooks are considered accountable documents in enforcement proceedings and may be subject to review. Therefore, the entries in the logbook must be accurate and detailed, but should not contain speculative information that could conflict with information presented in subsequent project deliverables and correspondence. Also be aware that the field logbooks for a site may be a primary source of information for depositions and other legal proceedings that may occur months or years after field work is complete and long after our memories have faded. The accuracy, neatness, and completeness of field logbooks are essential for recreating a meaningful account of events.

Field notes may also be recorded digitally, using a variety of software programs. The requirements and use of digital recording programs is not addressed in this standard operating procedure (SOP) because many items are unique to the selected software system. However, many of the principles discussed in this SOP will apply to the digital recording of field notes.

1.1 PURPOSE

The purpose of this SOP is to provide guidance to ensure that field logbook documentation collected during field activities meets all requirements for its later use. Among other things, field logbooks may be used for:

- Identifying, locating, labeling, and tracking samples
- Recording site activities and the whereabouts of field personnel throughout the day
- Documenting any deviations from the project approach, work plans, quality assurance project plans, health and safety plans, sampling plans, and any changes in project personnel
- Recording arrival and departure times for field personnel each morning and evening and weather conditions each day

- Describing photographs taken during the project.

In addition, the data recorded in the field logbook may later assist in the interpretation of analytical results. A complete and accurate logbook also aids in maintaining quality control, because it can verify adherence to project scope and requirements.

1.2 SCOPE

This SOP establishes the general requirements and procedures for documenting site activities in the field logbook.

1.3 DEFINITIONS

None.

1.4 REFERENCES

Compton, R.R. 1985. *Geology in the Field*. John Wiley and Sons. New York, NY.

1.5 REQUIREMENTS AND RESOURCES

The following items are required for field notation:

- Bound (sewn) notebooks
- Ballpoint pens or Sharpies with permanent waterproof ink
- 6-inch ruler (optional)

Field logbooks should be bound (sewn) with water-resistant and acid-proof covers, and each page should have preprinted lines or grids and numbered pages. They should be approximately 7¹/₂ by 4¹/₂ inches or 8¹/₂ by 11 inches in size. Loose-leaf sheets are not acceptable for use as a field logbook, although logs and field forms used to record field measurements and data are acceptable as loose-leaf sheets maintained in a three-ring binder with numbered pages, as a supplement to the logbook. If notes are written on loose paper, they must be transcribed as soon as possible into a bound field logbook by the same person who recorded the notes originally.

Ideally, distribution of logbooks should be controlled by a designated person in each office. This person assigns a document control number to each logbook, and records the assignment of each logbook distributed (name of person, date distributed, and project number). The purpose of this procedure is to ensure the integrity of the logbook before its use in the field, and to document each logbook assigned to a

project. In the event that more than one logbook is assigned to a project, this process will ensure that all logbooks are accounted for at project closeout.

2.0 PROCEDURES

The following subsections provide general guidelines and formatting requirements for field logbooks, and detailed procedures for completing field logbooks.

2.1 GENERAL GUIDELINES

- A separate field logbook must be maintained for each project. If a site consists of multiple subsites (or operable units), designate a separate field logbook for each subsite. Similarly, if multiple activities are occurring simultaneously requiring more than one task leader (for example, well installation, private well sampling, or geophysical survey), each task leader should maintain a separate field logbook to ensure that each activity is documented in sufficient detail.
- At larger sites, a general field log may be kept at the site trailer or designated field office to track site visitors, document daily safety meetings, and record overall site issues or occurrences.
- Data from multiple subsites may be entered into one logbook that contains only one type of information for special tasks, such as periodic well water-level measurements.
- All logbooks must be bound and contain consecutively numbered pages. If the pages are not pre-numbered, the sequential page number should be written at the top of each page.
- No pages can be removed from the logbook for any purpose.
- All information must be entered using permanent, waterproof ink, either a traditional ballpoint pen or a permanent marker. Do not use pens with water-based ink (typically identified as rollerball or gel ink pens) because the ink may wash out if the paper gets wet. Pencils are not permissible for field notes because information can be erased. The entries should be written dark enough so that the logbook can be easily photocopied.
- Be sure that all entries are legible. Use print rather than cursive writing and keep the logbook pages free of dirt and moisture to the extent possible.
- Set apart critical information such as sample numbers by circling or drawing a box around the critical data.
- Do not enter information in the logbook that is not related to the project. The language used in the logbook should be factual and objective. Avoid speculation that could conflict with information presented in subsequent project deliverables and correspondence (see Section 1.0 above).
- Use military time, unless otherwise specified by the client. If a logbook entry is not related to a specific event, set it aside with the identification as a “NOTE.”
- Include site sketches, as appropriate.
- Begin a new page for each day’s notes.
- Include the date, project number, and location (if the project has multiple locations) at the top of each page.

- At the end of a day, draw a single diagonal line through any unused lines on the page, and sign at the bottom of the page. Note and implement any client-specific requirements (for example, some clients require each logbook page to be signed).
- Write notes on every line of the logbook. Do not skip any pages or parts of pages unless a day's activity ends in the middle of a page.
- If a line is left blank for some reason, cross it out (with a single line) and initial to prevent unauthorized entries.
- Cross out (with a single line) and initial any edits to the logbook entries. Note and implement any client-specific requirements (for example, some clients also require that edits be dated). Edits should only be made if the initial entry is illegible or erroneous. Do not make corrections for grammar or style.

2.2 LOGBOOK FORMAT

The layout and organization of each field logbook should be consistent and generally follow the format guidelines presented below. Some clients or contracts may have specific formatting guidelines that differ somewhat from this SOP; review client requirements at the start of the project to help ensure any client-specific guidelines are integrated.

2.2.1 Logbook Cover

Spaces are usually provided on the inside front cover (or the opening page in some logbooks) for the company name, address, contact names, and telephone numbers. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page. Information to be included on the inside front cover or first page includes:

- Logbook document control number (assigned by issuer)
- "Book # of #" (determined by the project manager if there is more than one logbook for the project)
- Contract and task order numbers
- Name of the site and site location (city and state)
- Name of subsite (or operable unit), if applicable
- Type of activity, if the logbook is for a specific activity, such as well installation or indoor air sampling
- Beginning and ending dates of activities entered into the logbook

2.2.2 Inside Cover or First Page

Spaces are usually provided on the inside front cover (or the opening page in some logbooks) for the company name, address, contact names, and telephone numbers. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page. Information to be included on the inside front cover or first page includes:

- Tetra Tech project manager and site manager names and telephone numbers
- Tetra Tech office address
- Client contact and telephone number
- Site safety officer and telephone number
- Emergency contact telephone number (911, if applicable, or nearest hospital)
- Subcontractor contacts and telephone numbers
- Site property owner or property manager contact information

Note—some clients prohibit the inclusion of personally identifiable information such as personal mobile telephone numbers on official project records.

2.3 ENTERING INFORMATION IN THE LOGBOOK

The following lists provide guidance on the types of information to be included in a typical field logbook. This guidance is general and is not intended to be all-inclusive. Certain projects or clients may specify logbook requirements that are beyond the elements presented in this SOP.

2.3.1 General Daily Entries

- Document what time field personnel depart the Tetra Tech office and arrive at the hotel or site. If permitted by the client to charge travel time for site work, document what time personnel leave and arrive at the hotel each day. (This information may be needed at remote sites where hotel accommodations are not near the site.)
- Indicate when all subcontractors arrive and depart the site.
- Note weather conditions at the time of arrival on site and any changes to the weather that might affect completion of project tasks during the day.
- Include the date and project number at the top of each page.
- Document that a site safety meeting was held and include the basic contents of the meeting.
- List the level of personal protection to be used for health and safety.

- Summarize the day's planned activities.
- Summarize which activities each field team member will be doing.

2.3.2 Field Activity Entries

- Refer to field data collection forms for details about field data collection activities (for example time, date, depth of samples, and field measurements). If separate field sampling sheets are not used, see Section 2.3.3 regarding logbook entries for sampling activities.
- Refer to well purge forms, well construction logs, and other activity-specific forms as applicable rather than including this type of information in the field logbook. These other forms allow the information to be more accessible at a later date.
- List any air monitoring instrumentation used, with readings and locations.
- Refer to instrument field logs for equipment calibration information.
- Summarize pertinent conversations with site visitors (agency representatives, property owners, client contacts, and local citizens).
- Summarize any problems or deviations from the quality assurance project plan (QAPP) or field sampling plan.
- Document the activities and whereabouts of each team member. (As indicated in Section 2.1, multiple logbooks may be required to ensure sufficient detail for contemporaneous activities).
- Indicate when utility clearances are completed, including which companies participated.
- Indicate when verbal access to a property is obtained.
- Include names, addresses, and telephone numbers of any pertinent site contacts, property owners, and any other relevant personnel.
- Document when lunch breaks or other work stoppages occur.
- Include approximate scale for all diagrams. If a scale is not available, write "not to scale" on the diagram. Indicate the north direction on all maps and cross-sections, and label features on each diagram.

2.3.3 Sampling Activity Entries

The following information should typically be on a sample collection log and referenced in the logbook. If the project does not use sample sheets as a result of project-specific requirements, this information should be included in the logbook.

- Location description
- Names of samplers
- Collection time

- Designation of sample as a grab or composite sample
- Identification of blind duplicates or split samples
- Type of sample (water, sediment, soil gas, or other medium)
- On-site measurement data (such as pH, temperature, and specific conductivity)
- Field observations (odors, colors, weather)
- Preliminary sample description
- Type of preservative used
- Instrument readings, if applicable

2.3.4 Closing Daily Entries

- Describe decontamination procedures (personnel and equipment).
- Describe handling and disposition of any investigation-derived wastes.
- Summarize which planned activities were completed and which ones were not.
- Note the times that personnel depart the site for the day.
- Summarize any activities conducted after departing the site (paperwork, sample packaging, etc.). This may be required to document billable time incurred after field activities were completed for the day.

2.3.5 Photographic Log Entries

- Before using a digital camera, ensure that the system date and time are correct. Verify whether the timestamp is being recorded on the image, if required.
- Indicate in the text that photographs were taken and the location where the photographs can be found (for example, in the project file) and identify the photographer.
- Begin a new photolog page for each new field day.
- Record the time of photograph so that the image can be generally identified when reviewing the digital files.
- Note the direction in which the photograph was taken, along with any relevant details that might not be understood when looking at the photograph.
- In the event that a film camera is used, the sequential number of the image should also be recorded, and the time from the logbook will be the recorded time for the photograph.

2.4 LOGBOOK STORAGE

Custody of logbooks must be maintained at all times. During field activities, field personnel must keep the logbooks in a secure place (locked car, trailer, or field office) when the logbook is not in personal possession. When the field work is over, the logbook should be included in the project file, which should be in a secured file cabinet; in addition, if directed by the project manager, scan logbook pages for electronic file management upon returning to the office. The logbook may be referenced in preparing subsequent reports and scanned logbook pages may be included as an appendix to a report. However, it is advisable to obtain direction directly from the client before including the logbook as a report appendix, because its inclusion may not be appropriate in all cases.

2.5 HEALTH AND SAFETY CONSIDERATIONS

In addition to the procedures outlined in this SOP, all field staff must be aware of and follow the health and safety practices that result from the Activity Hazard Analyses (AHA) for a project. The AHAs include critical safety procedures, required controls, and minimum personal protective equipment necessary to address potential hazards. The hazards specific to project tasks must be identified and controlled to the extent practicable and communicated to all project personnel via the approved, project-specific health and safety plan.

SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

CALIBRATION OF AIR SAMPLING PUMP

SOP NO. 064

REVISION NO. 1

Last Reviewed: August 2020



Quality Assurance Approved

August 12, 2020

Date

1.0 BACKGROUND

Several instruments are available to calibrate low air flow rate. This standard operating procedure (SOP) will assume the use of a MesaLabs Bios DryCal Defender 510 or 520 for calibration of high volume (flow rate greater than 5 liters per minute (L/min)) and low volume (flow rate of 5 L/min or lower). This SOP also assumes the use of a low volume air sampling pump similar to the Sensidyne GilAir Plus, a digital air sampling pump, and the use of a high-volume air sampling pump similar to the SKC QuickTake® 30. The air calibration procedure discussed in this SOP will work for analog air sampling pumps as well, such as the Sensidyne GilAir 5 or Sensidyne Aircon 2. A DryCal calibrator is used to calibrate sample collecting devices, which includes an air sampling pump with attached media, such as filters, impingers, sampling tubes, and color detector tubes.

1.1 PURPOSE

This SOP establishes the requirements and procedures for calibrating a digital air sampling pump using a MesaLabs Bios DryCal Defender.

1.2 SCOPE

This SOP provides instruction on the calibration of a digital air sampling pump and sample media using a BIOS DryCal Defender Calibrator.

1.3 REFERENCES

Bios International Corporation. 2007. "Defender 500 Series User Manual" Form #MK01-25, Rev B. Bios, 2007.

Sensidyne, LP. 2011. "GilAir Plus Operation Manual." Form #360-0132-01, Rev D. Sensidyne.

SKC Inc. 2010. "QuickTake 30 Sample Pump Operating Instructions." Form #40079, Rev 1910. SKC Inc.

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1.4 REQUIREMENTS AND RESOURCES

To calibrate an air sampling pump, the following equipment is needed:

- Air sampling pump (GilAir Plus or QuickTake 30, or similar digital pump)
- DryCal calibrator (Bios Defender 500 series or similar)

- Sample media (mixed cellulose ester (MCE) membrane filter, polyurethane foam (PUF) tube, phase contrast microscopy (PCM) filter, etc.)
- Logbook or field data forms (can be electronic)
- Sample labels

The DryCal defender must be calibrated annually by an accredited vender to ensure accuracy and function.

2.0 PROCEDURE

The following procedure is used to calibrate a sampling pump with a Bios DryCal Defender 520 or 530. If only using a low volume air sampling pump, use a “medium” (50-5,000 milliliters per minute (mL/min)) model of the 520 or 530. If using only a high volume, or a high volume and a low volume air sampling pump, use a “high” (300-30,000 mL/min) model.

Before calibration can occur, establish a flow rate for the air sampling pump. This will require a review of the method, a discussion with the analytical laboratory, and a review of the established reporting limits. Check the calibration at the beginning and end of the sampling event to establish an average flow rate for the sampling event. Calibrate equipment in the field as close to the start of the sample time as possible in order to obtain an accurate representation of field conditions during the time of sampling.

The procedure for calibrating an air sampling pump is as follows:

1. Attach the tubing to the suction fitting ([Figure 1](#)).
2. Attach the sample media, additional tubing, and then the sample pump ([Figure 2](#)). If sampling with multiple pumps and media, calibrate each pump with the media that will be attached to that pump. Use flexible tubing to attach the sample media and pump to the DryCal calibrator. Ensure no kinks are present and use the shortest length of tubing as reasonable.
3. Turn on the DryCal calibrator. To power on, press the On/Off button in the lower right corner of the control panel for one second.
4. Navigate through the Defender menu screen using the four arrows on the control panel. Select your desired menu option using enter in the center of the four arrows. Ensure in “SETUP” that the units are set to your preference and continuous flow is set up to take 10 readings with one second between each reading.
5. Navigate to the “Measure” option on the menu screen. Select continuous and press enter.
6. Turn the sampling pump on. The continuous measurement on the DryCal calibrator should start automatically. You will see a reading count at the bottom of the display. To receive the average

flow rate, pause at the 10th reading by disconnecting the pump or hitting the enter button. This reading will be the flow rate you record for that pump.

7. Record the calibration information in a logbook or on electronic form where minute and total flow volume calculations will be calculated electronically. An example of an electronic form is shown in [Figure 3](#). Record the following information in the form:
 - Flow rate (start and end)
 - Serial number of the pump
 - Pump number
 - Date
 - Sample start and end times
 - Location of sample
 - Analysis
8. At the end of the sampling event, collect the end flow rate and end sample time. Put sample name, date, and end time on the sample label. Enter all information into an air calculation form and calculate total air volume for your samples. This can be done by hand, but it is recommended to use an electronic air calculation form. In order to calculate total air volume, average the start and end flow rates, determine the total minutes the pump was ran for using the start and flow times¹, multiply the average flow rate and total minutes.

Example:

Name	Pump Serial #	Location	Analysis	Start Time	End Time	Total Minutes	Start Flow (L/min)	End Flow (L/min)	Average Flow (L/min)	Total volume (Liters)
Sample 1	0001	East Perimeter	Metals	0702	1503	481	4.12	3.98	4.05	1948.05

Note: ¹Air sample pumps can fault. If the pumps are digital you can get the total run time from the pump. If the pumps are analog, the end time will be the time when the pump fault was observed. It is recommended to check air sampling pumps every hour to minimize time discrepancies.

9. Fill out the chain of custody with the information shown in the above example. Double check ALL calculations, be especially cautious that total minutes were calculated correctly. Double check the chain matches your total volume calculations.

FIGURE 1
BIOS DRYCAL DEFENDER LAYOUT

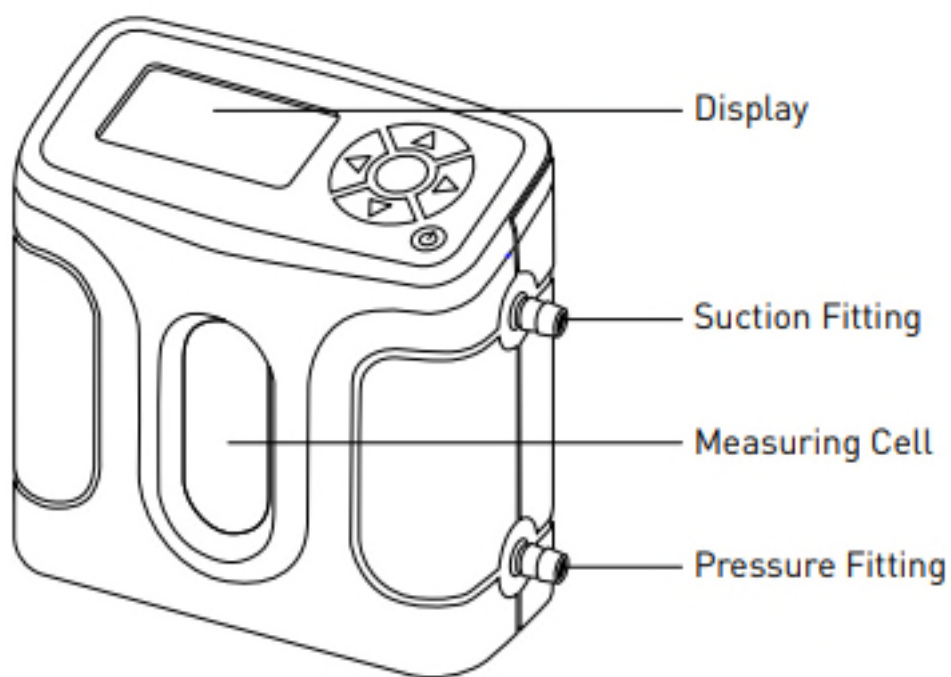


FIGURE 2
CALIBRATION SET UP



FIGURE 3
ELECTRONIC FORM EXAMPLE

Air Sampling Form										
Crawford Demolition ER										
TOLIN:										
Site: Crawford										
Method: NIOSH 7400 and NIOSH 7402										
Air Sampling Technician: C.Renner										
Date: 6/1/2020										
Primary Calibration: Bios DryCal D.C. Lite										
Pump ID	Sample I.D.	Start Time	Stop Time	Total Min.	Start Flow Rate (L/min)	Stop Flow Rate (L/min)	Corrected Flow Rate	Total Volume (liters)	Pump Fault	Location
QT080	CPP-SP-200601	7:15	12:00	284.00	9.98	9.98	9.980	2834.32		South Asbestos
GA208	CPP-SP-200601	7:15	12:00	285.00	4.02	3.82	3.920	1117.20		South Metals
GA116	CPP-SP-200601	7:15	12:00	285.00	5.01	5.06	5.035	1434.98		South PCB

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

AIR QUALITY MONITORING

SOP NO. 073

REVISION NO. 2

Last Reviewed: August 2020



Quality Assurance Approved

August 5, 2020

Date

1.0 BACKGROUND

Air quality monitoring is performed to evaluate concentrations of airborne chemicals or other materials. Particulate matter, volatile organic compounds (VOC), semivolatile organic compounds (SVOC), and other gases and vapors in the air can present potential health risks to workers and other receptors. Reliable measurements of airborne contaminants are necessary for selecting or upgrading personal protective equipment (PPE), delineating areas where protection is needed, assessing the potential health effects of exposure, evaluating site conditions, and evaluating the need for specific medical monitoring. Air monitoring is frequently used in emergency responses, where immediate information is needed about a release or threatened release of hazardous substances that present an imminent danger to public health, welfare, or the environment. Air monitoring is also commonly used as a screening tool to identify relatively impacted environmental media and to provide a real-time basis for selecting samples for laboratory analysis.

Various types of air monitoring instruments are available to monitor each type of airborne contaminant. Common air monitoring instruments used by Tetra Tech include photoionization detectors (PIDs), flame ionization detectors (FIDs), oxygen meters, combustible gas indicators, multigas meters that combine organic and toxic sensors for inorganics, single point monitors, colorimetric instruments, compound-specific instruments, and particulate matter monitors. It should be noted that this standard operating procedure (SOP) discusses only some of the air monitoring instruments available to field personnel. The particular type of meter or monitoring system to be used should be identified in the project work plan, field sampling plan, or health and safety plan, and should be selected on a site-specific basis depending on the data collection needs, the airborne contaminants to be monitored, and the sampling procedures to be used.

1.1 PURPOSE

This SOP establishes the requirements and procedures for using various instruments to conduct air monitoring in the field. It also discusses general factors to consider when conducting air monitoring.

1.2 SCOPE

This SOP provides only a broad overview of recommendations for monitoring air quality and applies to general procedures for calibrating and operating air monitoring equipment in the field. The project work plan or field sampling plan should identify types of instruments to be used and the actual project-specific field parameters to be measured. The project-specific healthy and safety plan should identify chemical-

specific action levels for health and safety purposes. For each type of air monitoring instrument, the manufacturer's manual should be consulted for specific operating instructions.

This SOP is to be used in conjunction with Tetra Tech EMI SOP No. 003, "Organic Vapor Air Monitoring," U.S. Environmental Protection Agency (EPA) Environmental Response Team (ERT) SOPs, and instrument manuals and quick start guides developed by manufacturers or by qualified users of the monitoring equipment.

1.3 DEFINITIONS

Breathing Zone: The area where field workers would be inhaling potentially impacted air, generally from about 3 to 5 feet above ground surface. The breathing zone will vary depending on the types of work activities being performed. Air monitoring is conducted in this zone to ensure that it is representative of the air being breathed by field team members.

Direct Reading Instrument: Instrumentation operating on various detection principles such as photoionization, photometry, or spectroscopy to provide real time readings of ambient contaminants in air.

1.4 REFERENCES

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1.5 REQUIREMENTS AND RESOURCES

Depending on the type of air quality monitoring to be conducted, some or all of the following equipment will be required:

- Particulate monitoring meter, such as the TSI, Inc. DustTrak II Aerosol Monitor Model 8530 or DustTrak DRX Model 8533/8534 or similar
- Organic Vapor Air Monitoring Meter, such as the RAE Systems AreaRAE Pro, MultiRAE Pro, or UltraRAE 3000
- Compound-specific or compound-class-specific air monitoring meters, such as the Honeywell Single Point Monitor or SPM Flex, Lumex RA-915M mercury vapor analyzer, Jerome mercury vapor analyzers, or RAE Systems MultiRAE Benzene

- Manufacturer-supplied calibration kits, including tubing, regulators, and zeroing equipment
- Manufacturer-supplied calibration gas
- Telemetry hardware, such as Rae Systems RAELink 3 modems, Safe Environment Engineering VIPER Lincs and Gateways, or Field Data Solutions radio modems
- Logbook or field data sheets (may be in electronic form)
- Laptop equipped with telemetry software and wireless internet

2.0 APPLICATIONS, DETECTION METHODS, AND LIMITATIONS

All direct-reading instruments have inherent constraints in their ability to detect gaseous organic or inorganic compounds and particulates. They usually detect or measure only specific classes of chemicals or particulates. Generally, many direct-reading instruments that have been designed to detect one particular substance also respond to other substances, causing interferences and possibly resulting in false readings. Applications, detection methods, and limitations of organic air monitoring instruments can be found in Tetra Tech SOP No. 003. The following subsections discuss general applications, detection methods, and limitations when using air monitoring equipment.

2.1 APPLICATIONS

Air monitoring is used to help establish criteria for worker safety, document potential exposures, evaluate site conditions, and determine protective measures for site personnel and surrounding public. Air monitoring instruments can be used alone or as a network integrated using wireless telemetry to monitor for multiple contaminants at numerous locations.

Multigas meters such as the RAE Systems MultiRAE Pro and AreaRAE Pro have slots for electrochemical, carbon dioxide, oxygen, or combustible sensors in addition to the PID. Electrochemical sensors are available for a wide range of toxic gases. A list of available MultiRae Pro and AreaRae Pro sensors is available on the manufacturer's website and in the instrument user guides. When operated in datalog mode, the instrument records sensor readings to internal memory for download after the monitoring event. Refer to EPA ERT SOP No. ERT-PROC-2139-20, "Operation of the MultiRae Pro Wireless Portable Detector" and EPA ERT SOP No. ERT-PROC-2066-20, "Operation of the AreaRae Wireless Multi-Gas Monitor" for comprehensive standard operating procedures for the MultiRae Pro and AreaRae Pro (EPA, 2020a; EPA, 2020b).

TSI DustTrak DRX monitors or similar particulate monitors can be used to obtain real-time readings of size-segregated mass fractions of particulates with aerodynamic diameters of 1 micron (PM_{1}), 2.5 micron ($PM_{2.5}$), 4 micron or respirable particles (PM_{4}), 10 micron or thoracic particles (PM_{10}), and total suspended particulates (TSP). DustTrak II monitors can provide real-time readings of $PM_{2.5}$ or any other mass fraction if the impactor for the specified particle size is installed in the monitor. Both the DustTrak DRX and DustTrak II electronically record particulate data as specified in the “RunMode” menu on the instrument screen. Refer to EPA ERT SOP No. EPA-PROC-2078-20, “Operation of the DustTrak Aerosol Monitors; Desktop DRX Model 8533EP and Handheld DRX Model 8534” for comprehensive standard operating procedures for the DustTrak DRX (EPA, 2020c).

Single Point Monitors such as the SPM Flex can detect specific chemicals or classes of chemicals, depending on the Chemcassette cartridge installed. A wide range of Chemcassettes are available for toxic gases; a full list is available on the manufacturer’s website. The SPM Flex can provide real-time readings of concentrations of the specified gas or gas family and electronically logs the data for download after the monitoring event. Refer to EPA ERT SOP No. EPA-PROC-2071-20, “Operation of the SPM Flex Gas Detector” for comprehensive standard operating procedures for the SPM Flex (EPA, 2020d).

Mercury Vapor Analyzers (MVAs) such as the Lumex RA-915+ Mercury Analyzer, RA-915M Mercury Analyzer, and the Jerome J505 Mercury Vapor Analyzer are capable of detecting mercury vapor in ambient air at concentrations from 2 to 200,000 nanograms per cubic meter (ng/m^3) (Lumex RA-915M) and 0.05 to 500 micrograms per cubic meter ($\mu g/m^3$) (Jerome J505 MVA). Both the Lumex RA915-M and Jerome J505 MVA provide real-time readings of mercury vapor concentrations and have the ability to electronically log the data for download after the monitoring event. When operated in “Monitoring” mode, the Lumex RA915-M is capable of running for a designated amount of time with periodical zero checks and datalogging. Refer to EPA Scientific, Engineering, Response and Analytical Services (SERAS) SOP No. 1729, “Operation of the Lumex RA-915+ Analyzer for Measuring Mercury Vapor Concentrations in Air” and EPA ERT SOP No. EPA-PROC-2080-20, “Operations of the Jerome J505 Mercury Analyzer” for comprehensive standard operating procedures for the Lumex RA-915+, Lumex RA-915M, and Jerome J505 MVA (EPA 2016; EPA 2020e)

2.2 DETECTION METHODS

The MultiRAE Pro and AreaRAE Pro electrochemical sensors measure the concentration of the toxic gas within an external circuit using oxidation and reduction reactions. Electrochemical sensors for oxygen (O_2) are available as well. The toxic sensor must be calibrated to the specific toxic gas the sensor is

designed to measure, or a member of the group of compounds the sensor is designed to measure. While some sensors are toxic compound specific, all sensors may respond negatively or positively to other compounds in the environment. Some electrochemical sensors such as nitric oxide (NO) and ammonia (NH₃) require a bias voltage to detect the gas and require an equilibrium (or warm-up) time of at least 6 hours after installation. Unbiased sensors require at least 10 minutes to stabilize.

There are two types of combustible sensors available for detecting LEL and methane, protected catalytic bead sensors and non-dispersive infrared (NDIR) sensors. Protected catalytic bead sensors contain a catalyzer that allows for oxidation of the combustion gas at temperatures well below their normal flash point. NDIR sensors utilize light and measure IR absorption at specified wavelengths to estimate concentrations of a gas. While catalytic bead sensors are not sensitive to only one chemical, NDIR sensors rely on chemical-specific IR absorbance to detect a single combustible gas.

TSI DustTrak monitors utilize light-scattering laser photometers to determine mass-based measurements of particulates. Both the DustTrak II and the DustTrak DRX draw aerosols into a sensing chamber using a diaphragm pump, and a sample flow is illuminated by a laser light. While the DustTrak II utilizes the voltage across the photodetector to determine particulate concentration, the DustTrak DRX utilizes the individual pulses from the photometer to make single particle measurements, allowing the monitor to simultaneously measure both the aerodynamic diameter of an individual particle, as well as its mass.

The Honeywell SPM Flex draws a gas sample to the Chemcassette tape-based optical gas detection system. The SPM Flex uses an optical scanning system to detect the presence of a gas based on a color change on the installed Chemcassette. Chemcassettes are available for a wide range of both specific toxic gases and classes of toxic gases; a list of available cassettes can be found in the SPM Flex User's Manual. It is important to note that when using a Chemcassette designed to monitor for a class of toxic gases, such as a mineral acid Chemcassette, the monitor is configured to report the concentration of one specific member of the target compound class. However, a color-change will be induced in the Chemcassette by any member of the target compound class. The specific configuration of the SPM Flex monitor, limit of detection, and instrument response time can vary widely by both Chemcassette and the specific target compound.

The Lumex RA-915+ and RA-915M utilize differential Zeeman atomic absorption spectrometry using high frequency modulation of light polarization (ZAAS-HFM). A mercury lamp, which is a radiation source, is placed into a permanent magnetic field. Two beams are propagated from the lamp to a photodetector, one passes through an analytical cell and one does not. When mercury vapor from a

sample is introduced into the analytical cell, the difference between the intensities of the beams increases proportionately to mercury vapor concentration. The Jerome J505 MVA uses atomic fluorescence spectroscopy (AFS), which uses a light source with a wavelength of 254nm. Any mercury present in the sample will absorb and re-emit the light, which is then measured by a photo multiplier tube (PMT)

2.3 LIMITATIONS

Toxic sensors in the MultiRae Pro and AreaRae Pro have the following limitations:

- Cannot be exposed to precipitation or operate in temperatures outside of the 14 to 113-degree Fahrenheit (°F) range.
- Cannot be used when liquid may be inadvertently drawn into the probe.
- Electrochemical sensors can respond to chemicals other than those they are designed to detect. Some sensors, such as Formaldehyde (HCHO) and HCN, have extremely high cross-sensitivities. Sensor-specific Rae Systems Technical Notes should be consulted prior to use. Rae Systems Technical notes are available on the manufacturer's website.
- When used in the field, it is recommended that the instrument's accuracy be checked on a daily basis. Silicones, phosphates and phosphorus containing compounds, acidic or basic atmospheres, and overexposure (especially for oxygen (O₂) and VOC sensors) can damage sensors or the PID lamp.
- Most Rae System toxic sensors have a life span of two years.

Combustible sensors in the MultiRae Pro and AreaRae Pro have the following limitations:

- Protected catalytic bead sensors must be used in an environment with sufficient oxygen (greater than 10%) in order to operate.
- Protected catalytic bead sensors do not distinguish between combustible gases. If concentrations of a specific combustible gas are desired, use an NDIR sensor for the desired gas.
- Combustible sensors have a shorter life span (about 1 year) than electrochemical sensors. Ensure that the sensor is not expired prior to use.
- Combustible sensors are susceptible to sensor poisoning, in which the presence of certain compounds (typically silicones and phosphorous-containing compounds) can degrade the performance of the sensor over time, resulting in under-reporting of combustible atmospheres.

Photometric particulate monitors such as the DustTrak DRX have the following limitations:

- High humidity or fog may cause elevated particulate readings. The use of the Heated Inlet Sample Conditioning module may mitigate these issues by maintaining a stable relative humidity level.
- Measurement accuracy is dependent on a wide particle size distribution and by the optical characteristics of the particles, such as density, size, shape, and composition.

Single Point Monitors such as the SPM Flex have the following limitations:

- Chemcassette tapes are highly sensitive to rain, fog, humidity, and condensation.

- Cannot be used in temperatures outside of the 32 to 104 °F range.
- Operation is calibrated for use at altitudes below 3,000 feet. Work at elevations above 3,000 ft may require manufacturer calibration.
- Not all Chemcassette reactions are chemical specific. A colorimetric indicator may react with several similar chemicals, but the concentration determined by the monitor will be for a specific compound, based on a compound-specific conversion factor.
- Chemcassettes have a short life span and often need to be refrigerated or stored in freezers. Additionally, there is a relatively long lead-time to obtain new Chemcassettes.

The Lumex RA-915+, Lumex RA-915M, and Jerome J505 MVA have the following limitations:

- MVAs should never be exposed to metallic mercury.
- The Lumex RA-915+ and Lumex RA-915M should not be used for long durations in environments with high concentrations of mercury vapor (greater than 10,000 ng/m³). If mercury vapors are present at high concentrations, operate the Lumex instruments in “High Concentrations” measuring mode or use a Jerome J505 MVA.
- Some interference with high levels of VOCs has been observed and noted. If operating any MVA in an environment with VOCs present, consider collecting air samples for laboratory analysis via National Institute for Occupational Safety and Health (NIOSH) Method 6009, *Mercury*.
- MVAs are sensitive to environmental conditions. If operating an MVA in an environment with variable environmental conditions, re-zero the instrument frequently. The MVA should never be exposed to water or dust.

3.0 PROCEDURES

3.1 TESTING AND CALIBRATION PROCEDURES

Each air monitoring instrument should be calibrated according to the manufacturer’s specifications.

General procedures applicable to most equipment are as follows:

- Equipment should be thoroughly cleaned, and then calibrated and tested before the startup of monitoring at each site.
- Equipment should be calibrated and tested using manufacturer-provided calibration gas and calibration connector kits.
- Batteries should be charged before the startup of field work, and the battery charge level should be checked at the start of each day. The battery charge life will vary depending on the monitoring instrument used, the application, and environmental conditions such as the temperature. Some instruments are equipped with an adapter that will allow the unit to be plugged into a car charger or charge from a car battery. It is recommended that extra batteries be kept on hand when conducting field work.
- Calibration and testing of field equipment should be documented every time it is performed. Calibration and testing information should be recorded in field logbooks, field data sheets, or electronic data capture forms.

- If testing and calibration measurements are out of tolerance, the instrument must be serviced or repaired.
- The manufacturer-recommended factory calibration schedule should be followed. If an instrument is due for factory calibration it should not be used in the field.

3.2 FIELD MEASUREMENT PROCEDURES

Each air monitoring instrument should be operated according to manufacturer's specifications. The actual field procedures will vary depending on the type of monitoring to be conducted. Many instruments are affected by moisture, humidity, and dust. Additionally, many instruments include a datalogging option. Even if wireless telemetry is utilized, the datalogging option should be selected to prevent losing air monitoring data. General procedural summaries and processes for air monitoring associated with initial surveys and offsite or perimeter monitoring are presented below.

3.2.1 Initial Surveys

Initial surveys are conducted upon first entry to an area with a potentially hazardous atmosphere. Initial surveys are performed relatively rapidly and are a screening process for collecting preliminary data to use for determining levels of PPE, establishing work zones, and establishing contaminated areas for further monitoring or sampling.

In most cases, project teams will have prior knowledge of the site and site contaminants, allowing air monitoring instrumentation to be selected based on the site-specific contaminants of concerns. When entering unknown environments, utilize the EPA Emergency Response Technical Group "Hazard Evaluation Flow Chart for Unknown" (EPA 2005). Intrinsically safe instrumentation should be used when there is a threat of atmospheres that may be explosive or conducive to ignition.

General procedures for conducting initial surveys are as follows:

- Following the instrument manual, calibrate and test air monitoring equipment. Multiple instruments may be necessary depending on the nature of the site.
- Record calibration information, site name, date and time, and pertinent weather information in a field logbook or on field data sheets.
- Approach the entrance to the site from the upwind direction, if possible. At the entry of the site, record the readings from each instrument in the breathing zone. Negative or non-detect results should also be recorded to demonstrate that the measurement was taken.
- Enter the site and record a measurement in each area of interest (ex: spill areas, frequently utilized spaces, current or historical chemical storage areas).

- Determine if measurements indicate sustained concentrations of contaminants in the breathing zone which are above action levels specified in the site-specific health and safety plan, or which otherwise do not meet healthy and safety criteria. Upgrade the level of PPE, implement engineering controls, and/or stop work if necessary.
- Once the initial survey is complete, download all instrument data and save in the project folder for site records or for future analysis.

Information obtained during initial surveys may lead to further monitoring. A more comprehensive survey and analysis for specific compounds may be warranted.

3.2.2 Off-Site and Perimeter Monitoring

Off-site and perimeter monitoring is typically conducted with the same instrumentation that is used for onsite monitoring. Since air is dynamic by nature, physical boundaries do not necessarily delineate the extent of contamination or the boundary of an area affected by a release. Monitoring at the perimeter of the site, or at locations off site provides information about pollutant migration. General procedures for conducting off-site and perimeter monitoring are as follows:

- Following the instrument manual, calibrate and test air monitoring equipment. Multiple instruments may be necessary depending on the nature of the site.
- Record calibration information, site name, date and time, and pertinent weather information in a field logbook or on field data sheets.
- Identify perimeter or offsite locations for monitoring. Generally, cardinal directions are acceptable for perimeter monitoring. Monitors may be adjusted or added based on wind direction and wind speed, or the presence of priority populations for monitoring, such as sensitive receptors.
- Once monitoring locations have been determined, place instruments in the breathing zone and record monitoring start times and readings. Ensure instruments are not in the way of traffic, work, or other activities that could damage or disturb them.
- If the monitoring period is prolonged, check on the instrument periodically to ensure proper function and accuracy. If sensor drift is suspected or observed, recalibrate the instrument and restart monitoring.
- At the end of the monitoring period, record the monitoring stop time and readings.
- Download all instrument data and save in the project folder for site records or for future analysis.

Lack of detections or negative results should not be interpreted as complete absence of airborne contaminants. It is possible that the compound class the instrument detects is not present or that the concentrations of the compounds are below the instrument's detection limits. The instrument detection limits should be presented with all site data.

3.3 AIR MONITORING TELEMETRY

Many air monitoring instruments are capable of generating a real-time data stream that can be incorporated into telemetry systems for remote monitoring. Telemetry systems make use of wireless data transmission technologies to convey monitoring results to a central location for viewing and storage. Common telemetry systems used for transmitting air monitoring data include EPA ERT's VIPER system and Honeywell's ProRAE Guardian system. The VIPER system can be operated using either wireless local area networks (WLAN)/cellular system or 900 MHz radio modems. Numerous air monitoring instruments can be incorporated in the VIPER system, including DustTrak DRX monitors, SPM Flex monitors, and RAE Systems equipment (for a full list of supported monitoring equipment, see www.response.epa.gov/VIPER). The ProRAE Guardian system utilizes 900 MHz radio modems or WLAN to transmit data. The ProRAE Guardian system supports most RAE Systems instruments, including AreaRAE Pro and MultiRAE Pro monitors.

When monitoring instruments are configured as part of a telemetry network, monitoring data are compiled and visualized in a telemetry software. Most telemetry software applications provide tools for visualizing trends in monitoring results, configuring alarms when results exceed action levels, and store monitoring data in a database application. Data transmitted to the telemetry software can be viewed in near real-time from a remote location, including simultaneous viewing of multiple types of instruments, positioned at multiple locations.

3.4 ACCURATE RECORDING AND INTERPRETATION

Air monitoring instruments must be operated, and the data interpreted by individuals who understand the operating principles and limitations of the instruments. At hazardous waste sites, where unknown and multiple contaminants are frequently encountered, instrument readings should be interpreted conservatively.

The following guidelines promote accurate recording and interpretation:

- Calibrate instruments in accordance with the manufacturer's instructions before and after every use.
- Conduct additional monitoring at any location where a positive response occurs.
- Report any readings of zero as nondetectable (ND) rather than as "clean." Quantities of chemicals may be present but at concentrations that are not detected by the instrument.

3.5 VARIABLES AFFECTING AIR MONITORING

Complex environments containing many substances, such as those associated with hazardous waste sites, pose significant challenges to accurately and safely assess airborne contaminants. Several independent and uncontrollable variables can affect airborne concentrations and instrument performance. These factors must be considered when conducting air monitoring and interpreting data. The following variables must be considered:

- **Temperature:** An increase in temperature increases the vapor pressure of most chemicals. Generally, worst-case emission of VOCs and SVOCs occur on the hottest day of site activities.
- **Wind speed and direction:** An increase in wind speed can affect airborne contaminant concentrations near free-standing contamination or a release. Wind speed and direction impacts the extent and paths of plumes of airborne contamination.
- **Rainfall:** Water from rainfall can cap vapors, gases, or dust from a site, reducing concentrations of airborne contaminants.
- **Moisture:** Particulates, including finely divided hazardous solids, are highly moisture-sensitive. Moisture can vary significantly with respect to location and time and can impact the accuracy of monitoring results across all instruments.
- **Background emissions:** Background emissions from other activities in the proximity of a site can affect instrument readings. Operations such as vehicle maintenance, fueling facilities, and road or landscape work can affect readings associated with perimeter monitoring. Any potential outside sources of emissions should be recorded in the logbook or on field data sheets.
- **Work activities:** Work activities often require the mechanical disturbance of contaminated materials, which may change the concentration and composition of airborne contaminants at a site. Monitoring should be conducted at all phases of a project to ensure no work activities create hazardous work environments that require upgraded PPE, engineering controls, or stop work.

Consult the manufacturer's manual to determine the instrument-specific impacts of environmental conditions.